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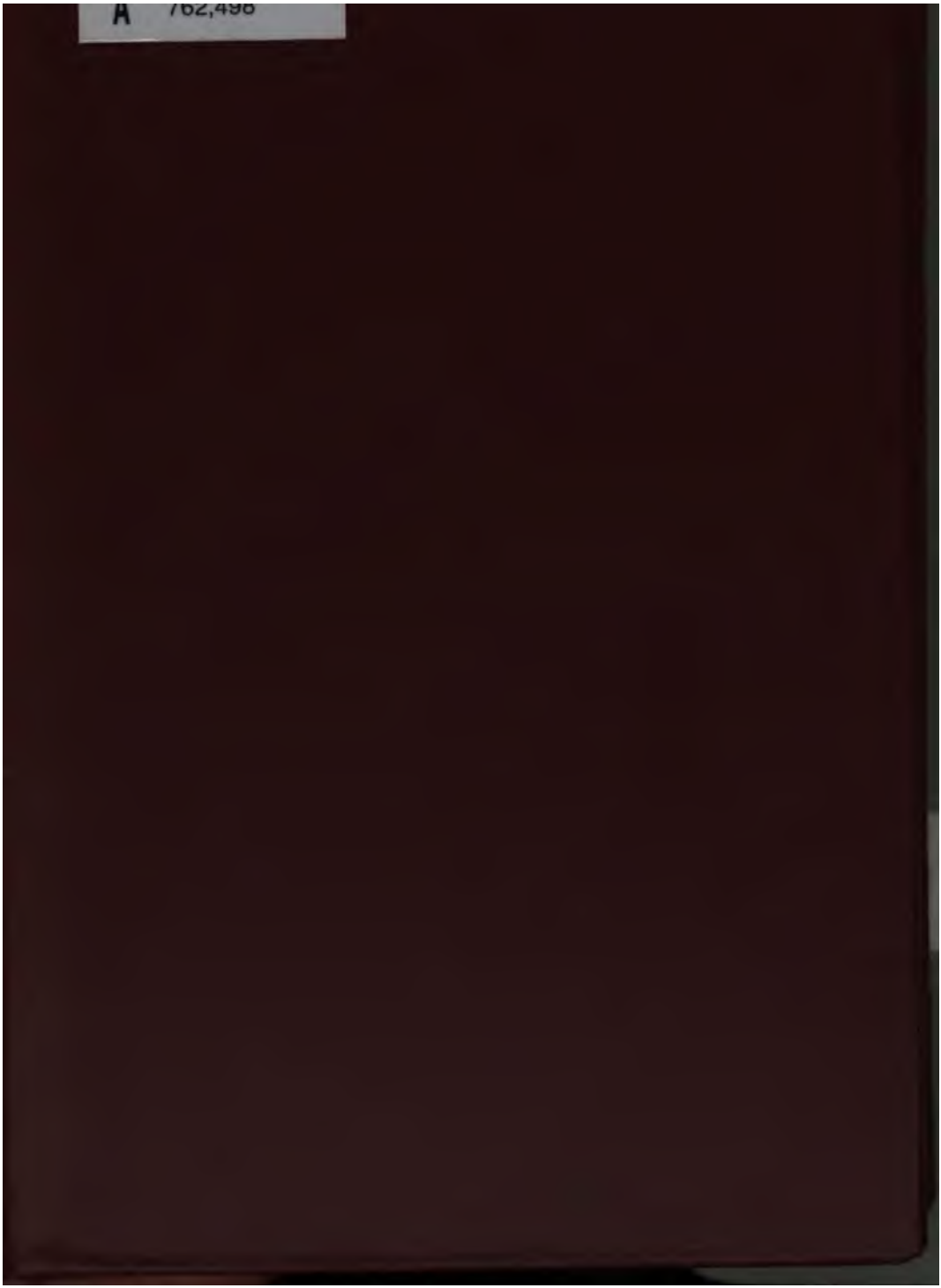
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INTRODUCTION.

The universal use of the Air Brake on passenger, and its ever increasing use on freight equipment makes a clear understanding of it of vital importance to every one concerned in the movement of trains whether he be an engineer, fireman, trainman or air brake inspector.

This understanding must consist of a clear knowledge of the principles that govern the mechanical appliances used and of the details of the contrivances adopted to obtain desired results; to this basic knowledge must be added familiarity with the difficulties met with in actual operation and the precise methods by which such difficulties may be overcome or obviated. This field of wide scope and infinite detail this volume covers. From it the student may learn of the construction of the two great systems of air brakes—"The Westinghouse" and "New York;" of the functions of the various parts; of the actual troubles that arise day by day in their operation; and of the specific means to be taken to overcome or prevent them.

To railway operatives, more than any other class, is committed the safety of human life and valuable property and no mechanical device ever invented has been more efficacious, and therefore beneficent, than the modern air brake, in safeguarding human lives and property in the course of transportation. But its efficiency depends upon its intelligent operation, and it is to the great credit of railway operatives that they have always shown an eager desire to attain the highest proficiency in this particular department

of their profession. It is the belief that this volume will afford them a better insight into the subject and thus aid them in their daily duties that prompts its submission to them.

In the preparation of the work the author has been favored with the advice and assistance of two of the highest experts of the country in air brake matters: Mr. L. M. Carlton and Mr. John Fulton. Much of the matter has also been contributed by Mr. E. W. Pratt, an expert in such matters. To Mr. G. W. Rhodes and Mr. Robert Quayle, both of the highest eminence in their profession, the author is indebted for examination of much of the matter with a view to the discovery and correction of inaccuracies and omissions. The volume has thus passed under the review of men pre-eminently fitted to judge its merits. The illustrations are authoritative, having in the main been prepared under the immediate direction of the Westinghouse and New York Air Brake Companies.

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Although an improvement over the continuous chain brake and other inventions of early days, it was still too slow in releasing (letting go its hold on the wheel), as all the air in the pipe and cylinders had to escape through the engineer's valve, the longer the train consequently the slower its operation. Another fault was, if a hose or pipe burst the brake was rendered useless. Moreover,

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if a train became parted the brake had no effect whatever upon the rear section.

These objections rendered it apparent that a wholly satisfactory brake required that the force (air) for applying it should be stored on each car, and so arranged that it could be used (i. e., the brake set) by those in the car, independent of the engineer. Also, that it should be automatic in its action, i. e., that any breakage or defect of the apparatus would set the brake. The most primitive conception of this idea was a design in which the operative force was a spring, so arranged as to be held under compression by the air in the pipe, and brought into action when the air escaped.

Automatic Air:—This improvement involved the necessity of a reservoir auxiliary to the engine for storing the power on each car; the next was to provide a way by which the stored pressure in the reservoir might be automatically admitted to the brake cylinder whenever the pressure in the train pipe escaped. These improvements were covered by a patent issued in 1872.

The device employed is known as the "triple valve." Like nearly all inventions of a mechanical nature, the first design was incomplete and passed through several stages before reaching a point where it was of simple and practical use. The valve in question, which is of a complicated nature, is located, in conjunction with the auxiliary reservoir and brake cylinder, beneath the car. Upon the reduction of the pressure in the train pipe (through which the compressed air is sup-

plied to the auxiliary reservoirs from the engine) this valve allows the compressed air in each auxiliary reservoir to pass into the brake cylinder, thus applying the brakes. Upon the pressure in the train pipe being restored the valve allows the air in the brake cylinder to escape to the atmosphere, thus releasing the brake, and opens the ports for the passage of air from the train pipe to the auxiliary reservoir, recharging the latter.

The perfection of the hose coupling between the cars also plays an important part in the development of the stored-air brake. A satisfactory automatic coupler is a desideratum of the greatest importance.

An air pump was patented in 1870. An objection to it was its complicated valve motion. One difficulty was in keeping the square piston rod properly packed in order to prevent friction and wear. Many of the changes in devices had relation to the reversing valve mechanism, but up to the year 1875 no satisfactory result had been accomplished. First, a horizontal rotary valve was used, then a double poppet valve, then a vertical rotary valve, and finally, a simple slide valve, the latter proving by far the most effective.

Many of the objects sought as necessary were finally covered by the pump of 1875.

After the introduction of the automatic brake it was discovered that to secure satisfactory results some plan for maintaining a uniform pressure of air without attention from the engineer was needed. The outgrowth of this was the pump

is based. It is known that a brake shoe that presses against the wheel sufficiently to cause the wheel to slide at a low rate of speed will not do so at a high rate of speed. Technically, the co-efficient of friction increases with the reduction of the velocity of the surfaces in contact.

The quick-action brake, under the emergency application, causes the shoe to press against the wheel with a force equal to ninety per cent. of the pressure of the wheel upon the rail. This is as high a percentage of braking power as is practicable without sliding the wheel at a slow speed. The "high-speed" brake, however, nearly doubles this braking power when first applied and then automatically reduces it as the speed of the train is reduced. This form of brake originally contemplated, on each car, an additional valve and cylinder, which were made operative by a greater reduction of pressure than the engineer should use, except in cases of emergency. The piston of this extra cylinder produced additional force upon the ordinary levers after the regular cylinder had acted. As the speed of the train was reduced, it rested with the engineer to gradually release the pressure from the additional cylinder. Two objections to this form or device were, first, that the engineer might use the "re-inforce" cylinder when not intending to do so, by the use, inadvertently, of too much air, thus sliding the wheels and running by the stopping point as well; and, second, in case of impending danger, say, ahead, if the engineer should leave his post, the brake would not

automatically regulate itself, but would either lose its "re-inforce" power immediately or else lock all the wheels as the speed reduced and, by sliding the whole train, precipitate it into the danger it was sought to avoid. The especial advantage it afforded was that on a loaded freight car the "re-inforce" valve could be "cut in," and on an empty car "cut out," and thus regulate the holding power of loaded and empty cars respectively, to a much greater extent than is otherwise done.

The high-speed brake, a modification of the re-inforce brake, consists of an automatic graduated relief valve screwed into the brake cylinder and also the increasing of the standard train line air pressure to nearly double the normal quantity.

The relief valve referred to is set at sixty pounds pressure, and in the ordinary use of the brake allows all air above this amount to escape to the atmosphere; but when it is applied in an emergency, the cylinder receives the extra pressure so quickly that the relief valve is forced to its extreme position, thereby opening a smaller escape which increases in size as the speed diminishes and finally closes when but sixty pounds remains in the cylinder.

This brake has been in use on many fast trains and has demonstrated its advantages and put to rest the fear at first expressed that sliding of wheels would ensue upon its use. It has other advantage over the ordinary quick-action brake, in this, that the cylinder pressure is limited to sixty pounds without reference to the adjustment

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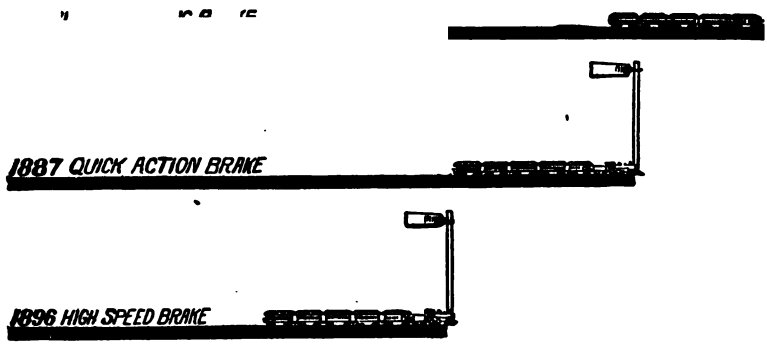
of the brake piston, and that several service applications can be made with equal effect without re-charging. As the use of sand upon the rails is essential to the attainment of the best results with this brake, it is desirable that locomotives should be equipped with automatic air sanding appliances which sand the rail when the handle of the engineer's valve is put in the emergency position.

FIG. 1



Some engines that alternate the handling of this brake with the standard brake have double governors and feed-valves for regulating to either the high or standard pressure, according to the equipment of the train.

In concluding the foregoing brief resumé of the "Evolution of the railway brake," it may be said that at first but one wheel of a vehicle had a brake; later, both pairs of wheels composing the truck to one end of a car were braked; still later, when

six-wheel trucks were required for heavy equipment, only the two outside pairs of wheels on each truck had brakes; later still, every pair of wheels under a passenger car was supplied with a pressure upon their brake shoes equal to ninety per cent. of the weight of the wheels upon the rail. A still greater change is noticeable on locomotives. While it was at one time questionable as to the advisability of applying a brake to locomotive driving wheels, afterwards it was made a requirement by law in America to equip engines and tenders as well as cars with power brakes. This renders every car and engine so nearly equal in stopping power that the greatest safety is had, and the minor jerking occasioned by the unequal braking power of the different vehicles is avoided.

An important consideration, it may be said, in connection with the brake is that part of the apparatus commonly called the shoe, or device that is applied directly to the wheel, and against which the friction is produced that retards the latter. It is manifest that the tenacity of the shoe depends not only on the force with which it is applied, but also upon the kind and quality of the material of which it is made. Another thing of great importance in connection with the shoe is the durability of the material used. The power with which this apparatus is applied and the tremendous friction consequent thereon must, it is apparent, quickly destroy the device unless the material is of the most durable character.

One of the devices in the early history of the

brake, by which it was made more effective, was the covering of that portion of it which touches the wheel—the sole, in fact—with several thicknesses of strong leather. This material may be said to have been used generally before the days of railroads. With the latter highways came heavier loads, moving at a higher speed. This required quicker and more effective application of the brakes. The heat resultant from this necessitated not only that the shoe should be of metal, but also the parts connected therewith.

Many different kinds of material have been used in connection with the brake shoe according to the needs of the service, and the skill of manufacturers. In the case of railroads a common device is made of cast or wrought iron; sometimes of cast steel, or combinations of iron and steel, wood, leather, cork, even paper. It is very desirable, in order to secure proper application, that the material, whatever it is, should be uniform.

An expert on the subject of brake shoes for railroads, a man of intelligence and a successful manufacturer*, writing on this subject, says: "The same air pressure throughout a train of cars on which shoes of different hardness are used, will apply a widely different friction on the wheels of the different cars. It is then impossible to obtain the maximum braking power for hard shoes without sliding those wheels to which soft shoes are applied. It is highly desirable to fix upon a standard mixture for foundrymen making cast iron

*George M. Sargent.

brake shoes. Brake shoes are made for three kinds of service: on chilled wheels, on steel-tired driver wheels, and on steel-tired coach wheels. Those designed for the first mentioned service are made of cast iron, or cast iron with wrought iron pieces in the face, or cast iron with chilled sections. When cast iron is used a strong, tough metal soft enough to grip the wheels is economical, although its first cost is greater than a burnt grate bar scrap mixture. A mixture of number two foundry car wheels and heavy cast scrap has given good results. The combination cast and wrought iron shoe is much more durable than the plain shoe, and more desirable in respect to uniformity, because the same amount of wrought iron, forming one-half the surface of each shoe will be nearly of the same hardness. * * * When two surfaces rub together, the harder will abrade the softer and the latter wear away quicker, but we are limited in the hardness of the shoes by the co-efficient of friction necessary. They must be of a uniform hardness, sufficient to grip the tire without scoring it, and afford friction necessary to make the stops. It is evident that for the different classes of engines, different kinds of shoes will be required. The suburban passenger engine, making frequent stops, should be equipped with shoes less hard than applied on a through passenger engine. The combination cast iron and steel shoe has the advantage that the proportion of each metal may be varied to suit the requirements of the service. Brake shoes for steel tired coach wheels are

applied under entirely different conditions. They are made either plain or flanged. The plain cast shoe should be soft and tough. Whatever kind of metal is used in the flange coach shoe, care should be taken that the shoe is a good fit to the tire, and so hung that the flange grooves in the shoes are directly opposite to the wheel flange, and above all that the brake beam be free to move laterally as the wheel and axle move. Experiments have proved that a brake beam hung rigidly from the truck, in combination with the flange brake shoes, forms a grinding machine capable of turning a V-shaped flange, and that even with the plain shoe, lateral motion is of decided advantage in protecting the flange."

In connection with the use of the brake shoe, it may be said that its application to the flange of the wheel was not discovered until long after it had been applied to the tread. This application was a new departure and a valuable one in many directions, as it added, it is manifest, greatly to the power of the brake. Its importance will grow with increased use and ability to handle it. The application of the flanged brake shoe to the drivers of locomotives is general. This because the flanged brake shoe tends to keep both tread and flange in the original form and by reason of the additional grip over the flange. One objection that has been made to the use of the flanged brake shoe on cars is that its use in connection with the tread creates a pressure so great that the wheel is inclined to slip. This, it is apparent, is not so

much an objection to the brake as a lack of proper adjustment of the power that manipulates it. It is claimed by manufacturers of flanged brake shoes that where the device is not used the tread wears away, while the flange of the wheel remains the same, thus creating a dangerous disparity.*

*Further reference to the brake shoe will be found in the volume on Cars.

CHAPTER II.

THE PRINCIPAL PARTS.

The principal parts of the air brake system (both Westinghouse and New York) are shown in plate G1 and A1 of the appendix to this volume. They are:

The Air Pump, which compresses the air.

A Governor, which governs the pump and regulates the amount of air to be compressed.

A Main Reservoir, in which an excess supply of compressed air is stored to promptly release and recharge the brakes.

An Engineer's Brake Valve, which regulates the flow of air *into* the train pipe and auxiliary reservoirs, to charge the train and release brakes; and *from* the train pipe to the atmosphere, for *applying* brakes.

The Duplex Air Gauge, which shows simultaneously the pressure in the main reservoir and in the train pipe.

The Train Pipe, which leads from the engineer's valve and thence throughout the train, supplying air to the apparatus on each car. By varying the air pressure in this pipe the brakes on each car automatically apply and release.

The Couplings and Angle Cocks, which connect the train pipe air from one car to another.

The Plain Automatic Triple Valve, which is used only upon the engine and tender. It controls communication between the train pipe and the auxiliary reservoir, the reservoir and the brake cylinder, and from the brake cylinder to the atmosphere.

The Quick-action Automatic Triple Valve, which is used upon cars. This valve is a duplicate of the "Plain" triple valve, with certain parts added thereto, which are inoperative unless an emergency requires that the train be stopped in the shortest possible distance.

The Auxiliary Reservoir (one for each brake), which stores under each car and engine, ready for instant use, sufficient compressed air to operate the brakes thereon. To apply brakes, the air from the auxiliary reservoir flows into the brake cylinder, the quantity admitted depending upon the braking force desired or train pipe reduction made.

The Conductor's Valve, which is placed in passenger cars, and provides a means for the trainmen to apply the brakes and stop the train, when desired to do so very quickly.

The Brake Cylinder, where the air is finally admitted when desired to apply the brakes.

Foundation Brake Gear, through which the brake cylinder transmits its force to the brake shoes.

The Pressure Retaining Valve, which is used by trainmen for holding fifteen pounds pressure in

the brake cylinder while (engineer recharges on) descending grades.

The Automatic Slack Adjuster, which automatically maintains a constant travel of the piston in the brake cylinder by taking up the slack of the foundation brake rigging as the brake shoes wear.

NOTE:—Descriptions of and instructions for manipulation of the Westinghouse "ET" Engine and Tender Brake Equipment, Modern Westinghouse Air Pumps (Compound), Modern Westinghouse Triple Valves, and the New York Locomotive Brake Equipment, Style B3, will be found in the Appendix hereto.

CHAPTER III.

THE AIR PUMP.

The air pump used in compressing the air for the use of the automatic air brake is placed on the locomotive, usually on the engineer's side of the boiler and immediately in front of the cab, although it is occasionally located similarly on the left-hand side, low enough not to obstruct the forward view. It is, however, becoming more and more the practice to place a pump on each side of the locomotive, so that there will be one in reserve should the other fail.

When we consider the many efforts made to reduce engine failures and understand that an air pump failure almost invariably results in a delay which is charged against the locomotive department as an engine failure, it seems as though it would be advisable to place two pumps on all locomotives or employ some such device as the Sweeney brake, illustrated and described elsewhere herein.

The air pump is a vertical compressor, consisting of two main cylinders, the upper one being the steam cylinder and the lower one the air cylinder. They are connected by a center casting, through which, in properly designed stuffing boxes, runs the piston rod connecting the main steam piston above with the air piston below.

To those not wishing to go into details of an explanation of the complete cycle of the movement of the pump, the following brief exposition of its principle is given:

Each upward and each downward stroke of the steam piston causes a corresponding movement of the air piston in the lower cylinder. In this air cylinder are two sets of valves that lift whenever the pressure below them is greater than that above; thus both the top and the bottom sides of the air piston have valves to admit air from the atmosphere when the piston is receding, and this valve closes as soon as the piston reverses; the air that is drawn in on the previous stroke is then compressed until the pressure in the air cylinder is greater than the pressure in the main reservoir, when the discharge valve is lifted from its seat and this compressed air discharges to the main reservoir. There is one upper and one lower discharge valve. The pump is double acting, discharging and drawing in air at one or the other side of the air piston on both the up and down strokes.

To move the air piston the steam must be alternately admitted first to one side and then to the other of the steam piston in the upper cylinder. This admission is regulated by the valve motion usually located in the upper head, which consists of a valve covering two steam ports leading to either side of the steam piston and an exhaust port leading to the atmosphere.

There are several standard sizes of air pumps in use on railroads. Each larger size was brought

into the service as the gradual increased air brake service demanded. The following is practically the development:

WESTINGHOUSE.

Steam Cylinder.	Air Cylinder.	Stroke.	Illustrated in Appendix.
6 inch	6 inch	13 inch	Plate B 6
8 "	7-½ "	9 "	Plate F 5
9-½ "	9-½ "	10 "	Plate F 4
11 "	11 "	12 "	Plate G 5
8-½ " h. p.	9 " h. p.	12 "	"Compound Air Pumps"
14-½ " l. p.	14-½ " l. p.	12 "	" "

NEW YORK (DUPLEX).

Pump No.	Diameter of Steam Cyl.	Diameter of L. P. Air Cyl.	Diameter of H. P. Air Cyl.	Stroke.	Illustrated in Appendix.
1	5 inch	7 inch	5 inch	9 inch	.....
2	7 inch	10 inch	7 inch	9 inch	Plate Q 2
5	8 inch	12 inch	8 inch	12 inch	Plate No. 5
6	7 inch	11 inch	7 inch	10 inch	.....

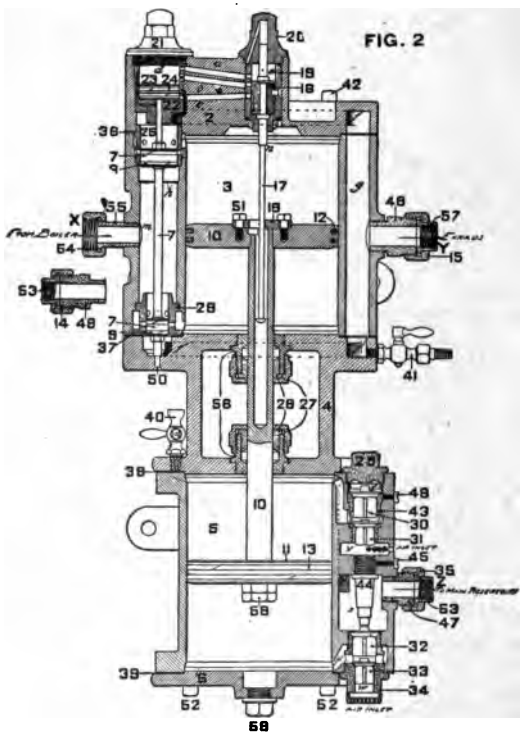
Owing to the similarity of the 6-inch and 8-inch, also the 9½-inch and 11-inch pumps, we will consider the 8-inch and 9½-inch.

The eight-inch Air Pump.—Figure 2 shows the 8-inch air pump in its upward stroke. (Figure 3 shows the down stroke.) 10 is the steam piston and rod; 11 the air piston; and piston valves 7, piston 23, reversing slide valve 16, reversing rod 17, and reversing plate 18 constitute the valve gear of the pump. Valves 30 and 32 are the discharge air valves, and 33 and 31 are the receiving air valves.

In service the pump governor is attached at x and has a suitable pipe connection with the steam supply. Steam enters chamber *m* and port *h*, always uniting chambers *m* and *e*, conducts steam from the former to the latter, which contains the reversing valve.

When reversing slide valve 16 is in the position

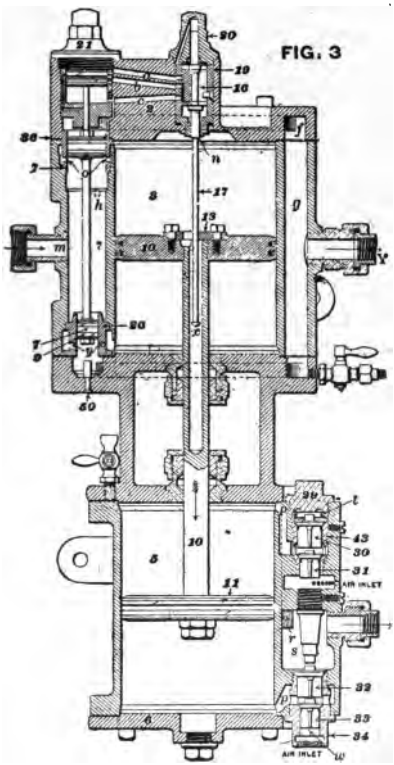
shown, steam passes from chamber *m*, through port *h*, into chamber *e*, and thence through port *a* into chamber *d* above reversing piston 23. The same



EIGHT-INCH AIR PUMP.

steam pressure now acts downward upon piston 23 and lower piston valve 7, and upward on upper piston valve 7; but, as the combined areas of piston 23 and lower piston valve 7 are greater than

that of upper piston valve 7, the steam forces piston 23 and piston valve 7 downward to the position shown. Steam is admitted to the cylinder through



the upper ports in bushing 26, raising piston 10, while the exhaust steam above piston 10 passes through the upper ports in bushing 25, thence through port *f, f,* shown by dotted lines, into cham-

ber *g*, and out at Y, through a suitable pipe, to the smoke arch, where it is discharged to the atmosphere.

When piston 10 has nearly completed its upward stroke, reversing plate 18 engages shoulder *n* and raises reversing slide valve 16 to its uppermost position, in which port *a* is closed and, as the cavity in the valve connects ports *b* and *c*, the steam above piston 23 is discharged through port *b*, the cavity in reversing slide valve 16, port *c*, and port *f*, *f*, into chamber *g*, and thence to the atmosphere through the exhaust pipe at Y.

There being now no pressure in chamber *d* to act downward upon piston 23, the upward force upon large piston valve 7 overbalances the downward force upon smaller piston valve 7 and both are raised so as to close the upper ports and uncover the lower ports in both bushings 25 and 26. Steam from chamber *m* is admitted through the lower ports of bushing 25 into the chamber above piston 10, forcing it down, and the steam below the piston is discharged through the lower ports in bushing 26 and the passage *f'*, *f'*, into chamber *g*, and out through the exhaust pipe at Y.

When piston 10 has nearly completed its downward stroke, the lower face of reversing plate 18 engages the button at the end of reversing rod 17, drawing the reversing slide valve down to the position shown, and the motion of the pump is again reversed.

During the upward stroke of the pump the air above piston 11 is compressed and discharged

through port *p* into the space between receiving valve 31 and discharge valve 30, forcing the latter from its seat and flowing through chamber *t* and port *r* into chamber *s*, and out at z to the main reservoir. The main-reservoir pressure in chamber *s* holds lower discharge valve 32 upon its seat during the upward stroke of the pump, and the tendency toward a vacuum below piston 11 allows receiving valve 33 to be forced from its seat by atmospheric pressure, which then enters into the lower part of the air cylinder. In the downward stroke of the pump the conditions are reversed; receiving valve 31 is lifted to fill the chamber above piston 11 as it descends, and the air compressed below the piston forces discharge valve 32 from its seat and flows through chamber *s* and the pipe connected at z to the main reservoir.

Recommendations concerning the care of the 9½-inch pump apply also to the 8-inch pump.

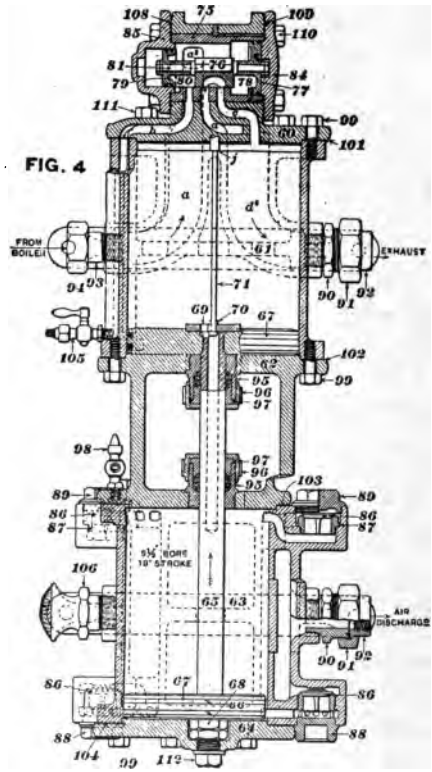
The 9½-Inch Pump (Westinghouse).—The 8-inch pump was designed to run at a moderate speed and against an air pressure of about 90 pounds, but as the number of air-braked cars in the trains and the trains themselves increased in length, it became apparent that a larger pump was needed. Therefore the 9½-inch pump was "brought out," and, owing to its superior capacity and construction, is rapidly displacing the 8-inch for every class of service.

The Steam Cylinder.—As with the 8-inch pump, the steam supply pipe is connected to the steam cylinder x, and the exhaust pipe at y. Figure 4

shows the pump about to make the up stroke; we will now suppose the steam supply is turned on, steam entering at x (Fig. 5) passes up through

FIG. 4

9½-INCH PUMP.

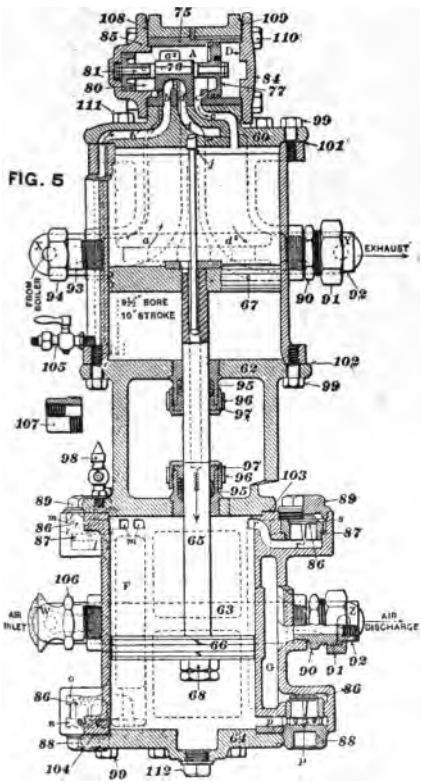


passage *a* into chamber A, thence down through the passage *b*, *b'*, *b''*, to the under side of piston 65, forcing it upward. But when the up stroke

nearly completed and before it strikes the top ad, the top of the reversing plate 69 strikes the

9½-INCH PUMP.

FIG. 5



shoulder *j* on the reversing rod 71, pushing it upward together with valve 72, to which it is connected. The position of valve 72 before it

is pushed upward is shown in the Fig. 8, where it will be clearly seen that all the steam ports to this chamber are closed except the passage *e*, which is the steam supply port and is always open; but as the valve 72 has now been pushed up so as to clear the passage *g*, steam flows through it (refer to Figures 5 and 7) into the space D at the right of the main steam valve 77, which together with the pressure constantly against the inside of piston 79 (as the space is always open to the exhaust and no pressure can accumulate there), piston 77 and 79 are forced to the left, carrying the slide valve 83 with them. This will allow the steam in the lower end of the cylinder to escape through the passage b″ b′ b (through which it entered) to the under side or cavity of the valve 83, thence through the exhaust port *d d′ d″* to the exhaust pipe connected at Y. Simultaneously with the exhaust or release of the steam in the lower part of the cylinder, steam from the chamber A is admitted by the same movement of the valve 83, into passage *c′ c′* to the top of 65, forcing it downward. But as was the case with the up stroke when the downward stroke is nearly completed and before it strikes the bottom head, the lower side of the reversing plate 69 strikes the button on the lower end of the reversing rod 71 and pulls the reversing rod and valve 72 downward to the position shown in Figure 8. This movement of the reversing valve shuts off the steam pressure to space D by closing the port *g*, and opening the exhaust port *h* of space D, thus

the pressure contained there escapes through the cavity of valve 72 into port *f*, thence to the pump exhaust. The pressure now no longer being maintained in space D, the area of the piston 77 being larger than that of the piston 79, the steam pressure in chamber A moves them, together with the valve 83, to the right again to the position shown in Figure 4, when the same action of the piston 65 will occur as already explained for the upward stroke.

The 9½-inch pump is provided with two drain cocks, 105 located in the steam passages *b''* and *a*, for the purpose of allowing the steam that condenses to water, when the pump is first started, to escape. These should always be opened when the pump is started and left open until the pump is thoroughly warm, when they should be closed.

On account of it being apparent for reasons already stated, that the 9½-inch pump will in time supersede the 8-inch, it was thought best to give a more detailed description of it than was necessary for the latter.

In the 9½-inch pump all the valve gear, except the reversing rod 71, is contained within the upper steam cylinder head. This is considered a great advantage over the 8-inch pump, for when the valve gear gets out of order a new head is simply substituted for the defective one, which requires but a few minutes to do; with the old 8-inch pump the whole upper cylinder had to be taken off, or the engine delayed until the repair was made.

For convenience of study an outside elevation

view of the main valve bushing 75 is given, sho ing the bushing removed from the steam cylind head (Figure 7), in addition to the longitudinal Figure 6 and transverse section in Figure 4. Tl ports *b* and *c* are the steam ports for the sli

THE 9½-INCH AIR PUMP.

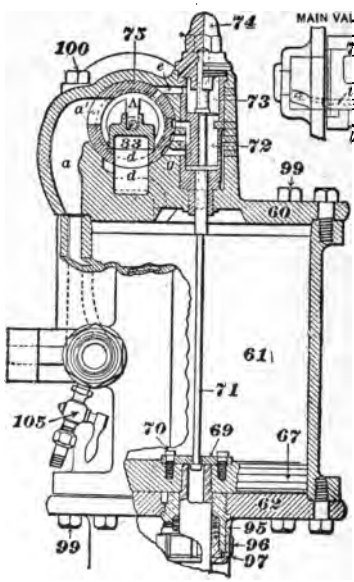


FIG. 6

This cut shows the position of reversing valve 72 when pump is making the up stroke.

Port *g* in main valve bushing is for live steam to piston 77; *h* is port for exhaust from this piston; *f* connects with exhaust port *d*.

FIG. 8

valve 83, and are the same ports marked *b* and in Figure 6 which pass through the bushing. Tl port *d* is the exhaust port for the valve 83, and also shown in both Figures 7 and 4. The groo *f* in Figure 7, it will be seen, connects with t exhaust port *d*. Groove *h* and *g* in Figure 6, whi

open into the space D between the piston 77 and the cylinder head 84, are for the purpose of letting steam in and out of this space to move piston 77, which in turn moves the slide valve 83. G being the groove through which the steam enters, and *h* through which it exhausts. The dotted lines *t* represent a small hole or passage-way drilled lengthwise through the bushing from the exhaust port groove *f* and extending into the main valve head 85 (not shown) opening into the chamber E. Figure 4 establishes a constant communication between it and the atmosphere, thus preventing any pressure that might leak past the packing rings of piston 79, from accumulation there, which would prevent the main valve 76 from taking the stroke to the left. The small hole indicated by *e* at the top of the bushing Figure 6 connects with the passage *e'* in Figure 7 and provides the means of maintaining a constant steam pressure in chamber C, where the reversing valve 72 works, and supplying it with steam to work the main valve 76.

The main valve 76 consists of two pistons, 77 being a large one, while the one 79 is considerably smaller. These pistons are connected together by the piston rod 81; and the slide valve 83 fits between two shoulders of this piston rod, therefore whenever the pistons are moved by the action of the reversing valve 72, the slide valve 83 is carried along, which results in steam being admitted and released alternately in both ends of the pump cylinder 61. The slide valve 83 is the ordinary type of D valve similar to the slide valve of a locomo-

tive. A small port *o* will be noticed leading do from the cap nut 74 in Figure 7 and appear in the illustration to end with the limit of the r but this is not the fact; it connects with a gro running around the outside of the top of revers valve bushing 73. From this, another groove c nects it by a small port with the upper end of

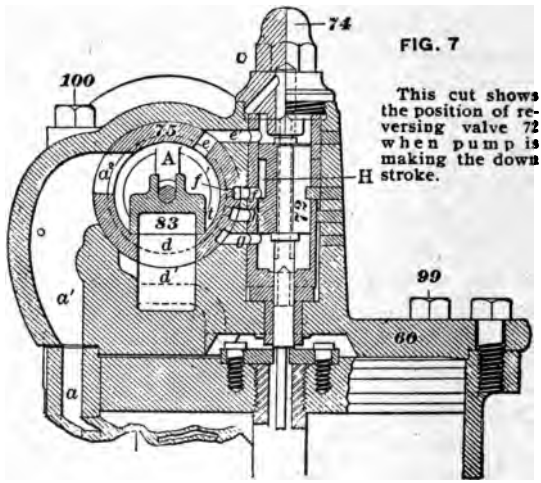


FIG. 7

This cut shows the position of reversing valve 72 when pump is making the down stroke.

steam cylinder. (Also not shown.) By this me the upper end of the steam cylinder and the sm space above the end of the reversing valve st 71 are always connected. This is for two reaso (1) to equalize the pressure above and below rod 71 so that, with the pump at work, the reve ing valve and rod will not move except when latter is operated by the reversing valve plate

(2) the steam carries lubrication to the stem where it works in the cap.

The Air Cylinder.—The construction and action of the air cylinder of the 9½-inch pump is identically the same as explained for the 8-inch pump, except that the receiving valves are on the opposite side of the cylinder to the discharge valves, and there is but one air inlet w, through which both ends of the cylinder draw their air; as passage F extends the length of the cylinder connecting both receiving valves. The discharge valves appear to the right in the illustration, the passage G connecting them as passage F does the receiving valves. The discharge pipe to main reservoir being connected at Z, which opens into passage G. (Fig. 5.)

The lifts of the air valve are all the same, the two top valves being regulated by the distance the nuts 89 are screwed down, and the two bottom valves are regulated by the distance the bushings ss that contain them are screwed up. The nuts and bushings are screwed up tight, to prevent leakage. The lift is given by filing off the top of air valve.

New York No. 2 Duplex Pump.—This pump (Figure 9) is duplex (or double), as its name indicates. The piston on either cylinder reverses the valve motion of the other cylinder.

There are three sizes of duplex pumps, No. 1. No. 2 and No. 5, but as they are the same in construction and action, a description of one suffices for all three. The steam cylinders are placed underneath the air cylinders instead of above, as

ing rods 7 and 8 and are drawn up and down in th bushings 16 and 17 by reversing plates 20 comin in contact with the button *a* and shoulder *b* on th reversing rods.

The cap nuts 15 screw into the lower head an secure the bushings 16 and 17 more firmly in plac The cap nuts 15 are bored hollow so as to act a guides for the lower ends of the reversing rod A hole *c* is bored through the lower end of th reversing rods so as to give an outlet into th cylinder for any steam that might leak past th rod ends into the space *d,* in the cap nuts an balance the pressure on ends of rod. There ar six air valves in the air end of the pump, an each should have its proper lift. The air inlet c receiving valve 9 and 10, and intermediate valv 11 and 12 are located between the two air cyli ders; the final discharge valves 13 and 14 are t the left of the high pressure cylinder. 53 are th air cylinder oil cups. 54 is a drain cock to car away the condensation that accumulates in th lower head when the pump is first started an before it is warmed up.

Pumps are provided with steam and exhau opening on both sides of the pump (one bein closed with a plug) so that they can be placed o either the right or left side of the locomotive b simply changing the plugs.

The Steam End.—The steam cylinders and lowe heads containing the valve motion of the duple pump are generally referred to as the *steam en* of the pump, both upper cylinders being spoken c

as the *air end.* They will be treated under these heads.

When steam enters the pump through the pipe 56, it fills the slide valve chamber A, through the port *e,* and the slide valve chamber B by the steam passing through the passage 19 (shown by lines dotted) with port *e'*. In these places steam is constant except when shut off at the globe valve by hand or by the governor; passage 19 is in reality a part of the valve chests, it merely provides a means of conveying the steam to the slide valve 6. The position of the pistons shown in the illustration are as they appear when working, not as they are when steam is first turned on after a period of rest; as in this case both pistons almost invariably are at the bottom of the cylinders, having settled there by gravity. But in order to make the description of its action less complicated, and therefore more easily comprehended, we will presume that the pistons are in the positions shown when steam is first turned on. Having already described the flow of steam into the steam chest, we will now explain the movement of the pistons and without first referring to the illustration let us suppose that both pistons 21-22 have gravitated to the bottom. This also permits both steam slide valves 5 and 6 to be at the bottom of bushings, consequently the upper steam passages must be open. Steam will flow through port 23 in on top of piston 22; simultaneously with this, steam will flow through port 26 to the under side of piston 21, causing it to make the upward stroke. Just

before it completes its stroke the tappet plate 2
engages with the button *a* on end of valve ste
which lifts valve 6 upward, bringing the cavity o
the valve to open port 23 with the exhaust port c
permitting steam that passed to the top of pisto
22 to be exhausted to the atmosphere, at the sam
time opening port 27 to under side of piston 2
causing it to rise. Just before piston 22 complete
its stroke the tappet plate 20 engages with the bu
tons *a* on its valve stem 7, lifting valve 5 upwar
as shown in Figure 9, bringing the cavity of th
valve to open port 26 with the exhaust port D, pe
mitting steam that passed to the bottom of pisto
21 to be exhausted to the atmosphere, at the sam
time permitting steam to pass through port 28
upper side of piston 21, causing it to descen
Just before it completes its stroke the tappet pla
20 engages the shoulder *b* on valve stem 8, a
pushes it down, which carries with it slide val
6, which opens passage 27 to the exhaust port
(through cavity of the valve) thus permitting th
pressure below piston 22 to escape to the atmo
phere. The same down movement of valve 6 a
lows steam from chamber B to feed into cylind
1 above piston 22, driving it down. Just before
reaches the bottom the reversing plate 20 strik
the shoulder *b* on the valve stem 7 and pushes
down, carrying with it slide valve 5, which open
passage 28 to the exhaust port D (through cavit
of valve) thus permitting the pressure above pi
ton 21 to escape to the atmosphere. This sam
movement of valve 5 allows steam from chambe

A to again feed into cylinder 2 below piston 21, which forces it upward for a second revolution. This completes a full up and down stroke of both pistons. It will now be readily understood that the valve and action of the cylinder on one side control the supply of steam to the opposite side. First the right piston goes up and waits at the top of the cylinder till the left one follows and completes the up stroke, then the right piston starts down, while the left piston waits until the right completes its stroke, when the left one follows, first one waiting for the other. Thus the two pistons do not start to make a stroke at the same time from opposite directions, but both move in the same direction; first one then the other, but never both moving at the same time.

The drain cock 54 should always be opened before starting the pump to work, and left open until the pump has warmed up and condensation ceased.

The Air End.—As has already been explained, the air pistons in the air cylinder are attached to the same piston rods 18 as the steam pistons: therefore with every up and down movement of the steam piston, the air pistons are carried with them.

Valves 9 and 10 are receiving valves for cylinder 2. Valves 11 and 12 are receiving valves for cylinder 1 and also act as discharge valves for cylinder 2. Valves 13 and 14 are final discharge valves for cylinder 1.

Operation.—Each piston waits until the other piston completes its stroke before making its re-

before it completes its stroke the tappet plate 2 engages with the button *a* on end of valve ste which lifts valve 6 upward, bringing the cavity o the valve to open port 23 with the exhaust port permitting steam that passed to the top of pist 22 to be exhausted to the atmosphere, at the san time opening port 27 to under side of piston 2 causing it to rise. Just before piston 22 complet its stroke the tappet plate 20 engages with the bu tons *a* on its valve stem 7, lifting valve 5 upwa as shown in Figure 9, bringing the cavity of t valve to open port 26 with the exhaust port D, pe mitting steam that passed to the bottom of pist 21 to be exhausted to the atmosphere, at the san time permitting steam to pass through port 28 upper side of piston 21, causing it to descen Just before it completes its stroke the tappet pla 20 engages the shoulder *b* on valve stem 8, a pushes it down, which carries with it slide val 6, which opens passage 27 to the exhaust port (through cavity of the valve) thus permitting t pressure below piston 22 to escape to the atmo phere. The same down movement of valve 6 a lows steam from chamber B to feed into cylind 1 above piston 22, driving it down. Just before reaches the bottom the reversing plate 20 strik the shoulder *b* on the valve stem 7 and pushes down, carrying with it slide valve 5, which ope passage 28 to the exhaust port D (through cavi of valve) thus permitting the pressure above pi ton 21 to escape to the atmosphere. This san movement of valve 5 allows steam from chamb

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Operation.—Each piston waits until the other piston completes its stroke before making its re-

turn stroke. Piston 32 makes the up stroke first; as it does so it compresses the air ahead of it and leaves a vacuum behind it in cylinder No. 2, and the pressure of the atmosphere on the outside raises valve 10, filling the space in the cylinder behind the moving piston with air at atmospheric pressure. When piston 32 completes its stroke it waits for piston 31 to make a stroke. As piston 31 moves upward it compresses the air ahead of it and makes a vacuum behind it in cylinder 1. The pressure of the atmosphere raises valves 10 and 12 and the air rushes in behind piston 31 to fill this vacuum. Now both pistons are at the extreme upper end of their cylinders and both are filled with air at atmospheric pressure. Cylinder 2 has double the volume of cylinder 1.

Piston 32 commences its down stroke, valve 10 is held on its seat. The air in cylinder 2, under the piston, is compressed; this raises valve 12 and allows the air to discharge from cylinder 2 to cylinder 1, underneath piston 31. At the same time that cylinder 2 is discharging its contents to cylinder 1, a vacuum is forming behind piston 32, which fills the upper end of cylinder 2 with free air through valve 9. After discharging the air that was in cylinder 2 into cylinder 1, and after completing its stroke, piston 32 waits for piston 31 to make its downward stroke. The combined contents of cylinders 1 and 2 are contained in cylinder 1 under piston 31, and as piston 31 commences its downward stroke, valve 12 seats, discharge valve

14 lifts and the air is discharged through passage E and pipe leading to main reservoir. While piston 31 is compressing the air from the lower end of cylinder 1, to the main reservoir, the upper end of cylinder 1 fills with free air through valves 9 and 11. After piston 31 completes its down stroke piston 32 compresses the free air in cylinder 2 through valve 11 into cylinder 1, and after completing its stroke, piston 32 waits for piston 31, and as piston 31 commences its upward stroke, valve 11 seats, discharge valve 13 lifts, and the air is discharged through same passage E and pipe to main reservoir.

At each stroke of the pistons each cylinder fills with free air; at each stroke of piston 32 air is discharged from cylinder 2 to cylinder 1 to a pressure of about 40 lbs., and from there to the main reservoir. Since cylinder 2 is twice as large in volume as cylinder 1, each complete stroke of both pistons handles three measures of air with two measures of steam.

The cocks 53 are for oiling the air cylinders. Each air cylinder should be given a tablespoonful of oil before starting the pump prior to making a trip on the road. Valve oil is best to use in the air cylinder.

Air Cylinder Oil Cups.—The heavy duty imposed on the air pump in furnishing compressed air at high pressure for modern passenger trains, and in much larger volume than formerly, for long freight trains, makes it necessary, to insure perfect lubrication while the pump is working, to use

turn stroke. Piston 32 makes the up stroke first; as it does so it compresses the air ahead of it and leaves a vacuum behind it in cylinder No. 2, and the pressure of the atmosphere on the outside raises valve 10, filling the space in the cylinder behind the moving piston with air at atmospheric pressure. When piston 32 completes its stroke it waits for piston 31 to make a stroke. As piston 31 moves upward it compresses the air ahead of it and makes a vacuum behind it in cylinder 1. The pressure of the atmosphere raises valves 10 and 12 and the air rushes in behind piston 31 to fill this vacuum. Now both pistons are at the extreme upper end of their cylinders and both are filled with air at atmospheric pressure. Cylinder 2 has double the volume of cylinder 1.

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14 lifts and the air is discharged through passage E and pipe leading to main reservoir. While piston 31 is compressing the air from the lower end of cylinder 1, to the main reservoir, the upper end of cylinder 1 fills with free air through valves 9 and 11. After piston 31 completes its down stroke piston 32 compresses the free air in cylinder 2 through valve 11 into cylinder 1, and after completing its stroke, piston 32 waits for piston 31, and as piston 31 commences its upward stroke, valve 11 seats, discharge valve 13 lifts, and the air is discharged through same passage E and pipe to main reservoir.

At each stroke of the pistons each cylinder fills with free air; at each stroke of piston 32 air is discharged from cylinder 2 to cylinder 1 to a pressure of about 40 lbs., and from there to the main reservoir. Since cylinder 2 is twice as large in volume as cylinder 1, each complete stroke of both pistons handles three measures of air with two measures of steam.

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Air Cylinder Oil Cups.—The heavy duty imposed on the air pump in furnishing compressed air at high pressure for modern passenger trains, and in much larger volume than formerly, for long freight trains, makes it necessary, to insure perfect lubrication while the pump is working, to use

a reliable automatic device that will lubricate the air cylinders at an even rate.

These automatic oil cups Figures 10 and 11 sup-

AUTOMATIC AIR CYLINDER OIL CUPS

WESTINGHOUSE

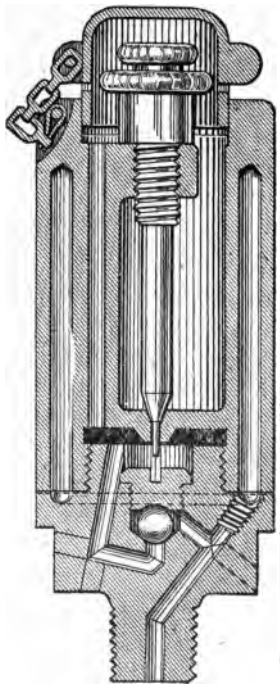


FIG. 10

NEW YORK

STYLE B.

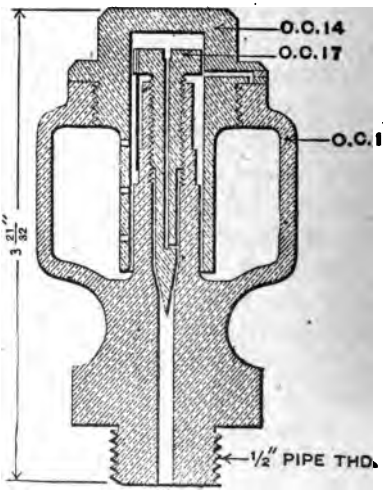
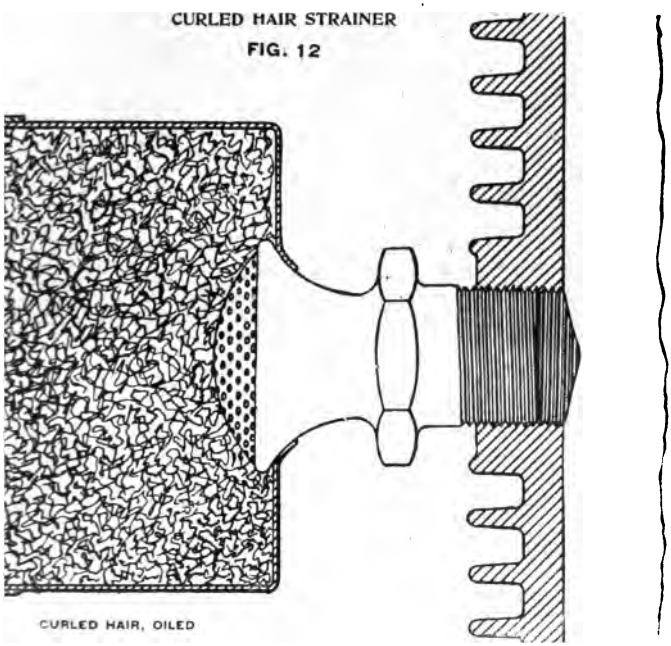


FIG. 11

ply oil to the air cylinders only when the air pump is working, so that although they perform the service required of them effectively, they also per-

ı it with a maximum economy in the use of oil. ir use will double the life of the air cylinders, ting rings and piston rod packing, as well as ·ent hot pumps and the annoyance caused by accumulation of gum in other parts of the ine equipment, due to the imperfect, wasteful



uneven lubrication of the air cylinders here- ·re in vogue.

·url·d Hair Strainer.—Figure 12. This device ·ry simple; the casing is loosely filled with the · best of curled hair, oiled, and as the air

passes to pump the dust and dirt in it adh to the oiled hair and the air is admitted to p pure. All that is necessary to keep this in working order is to remove the hair about e two weeks, wash it in kerosene and then apı small amount of valve oil and return to ca The air pump has to compress a vast amour air on our trains of to-day, and this air is dı from very dusty and dirty surroundings an it is drawn into the air cylinder for compres it absorbs the lubrication, thus causing the p to wear more rapidly. A good strainer will long the life of the air cylinder.

NOTE:—Descriptions of and instructions for manipulati Modern Westinghouse Air Pumps (Compound), will be fou the Appendix hereto.

CHAPTER IV.

THE AIR PUMP GOVERNOR.

The air pump governor (plates F 7 and Q 7 Appendix) is a device by which the steam supply to the air pump is automatically stopped when a sufficient amount of air pressure has been obtained; it also automatically starts the pump again when the air pressure has been reduced below the desired amount.

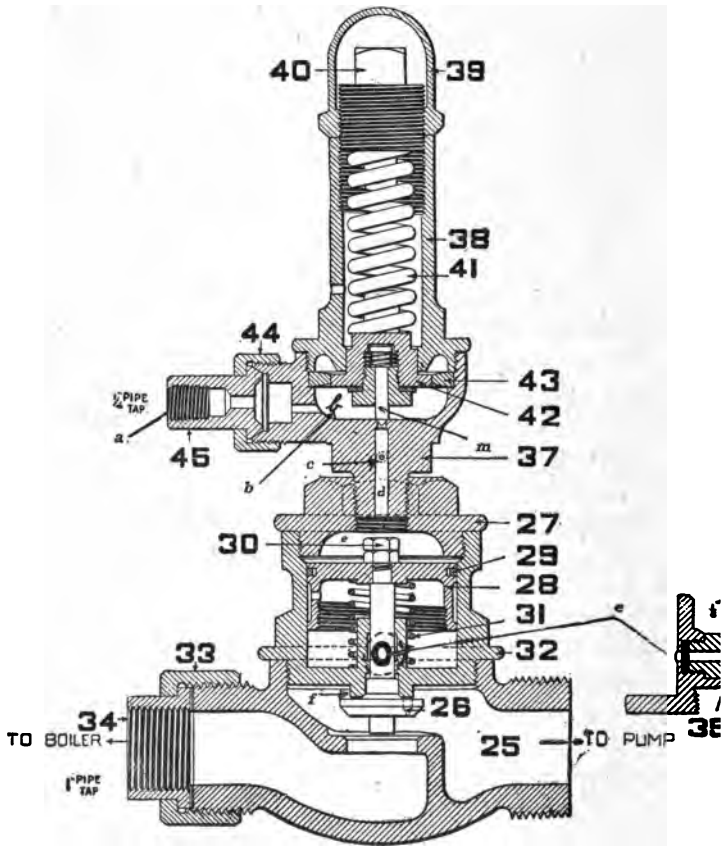
Operation.—All the steam from the boiler to the pump must pass through the bottom of the governor containing the steam valve. This valve is closed by a piston operated upon by air pressure above it. When there is no air pressure above the piston, it is held open by a combined action of the spring below it and by boiler pressure below the steam valve. As the boiler pressure and spring act constantly, it is only necessary to see how the air pressure is admitted to and taken from the top of the piston, to understand the working of the governor. See Figure 13.

The top of the governor contains a thin flexible diaphragm 42 holding a small pin-valve *m* which regulates the port leading to the top of the piston 28. The diaphragm 42 is held firmly at outside edge by spring casing 38. The diaphragm 42 has an adjustable spring 41 above it and air pressure on the under side of it. The center of

ONE-INCH PUMP GOVERNOR

FIG. 13

WESTINGHOUSE PUMP GOVERNOR



it is free to move up and down as conditions may require. With the F6 or G6 form of engineer's valve, having a feed valve attachment, the air connection to the governor at *a* is from the main reservoir pressure and spring 38 is adjusted by the nuts above to withstand about 90 pounds of air pressure; where the air connection is from the train line it is set to withstand 70 pounds pressure under the diaphragm in chamber *b* before it raises and opens the pin valve *m*, letting air pressure upon the piston and stopping the pump. The piston 28 is much larger than the steam valve 26, therefore 70 or 90 pounds of air can easily overcome 180 to 200 pounds of steam. When, from use or leakage, the air pressure drops below the required amount, the spring 41 and diaphragm 42 closes the pin-valve *m* and the air above the piston escaping, through port *c*, allows the steam valve to raise and admit steam to start the pump.

Relief port *c* will waste a small amount of air when the required pressure is maintained, and will start the pump quickly when pressure is reduced. If port *c* is clogged from any cause the air above piston 28 could not escape, thus the pump would remain idle a considerable length of time and lose a large quantity of air before starting.

The waste pipe connection 35 is made to carry away from the lower side of piston 28, any air pressure that might leak through the packing 29 or steam pressure that might come through the joint *f* of steam valve 26. The position in the

casing of the stud 35 is shown by dotted lines at *e*; a cross section of the stud 35 and nut 36 is also shown.

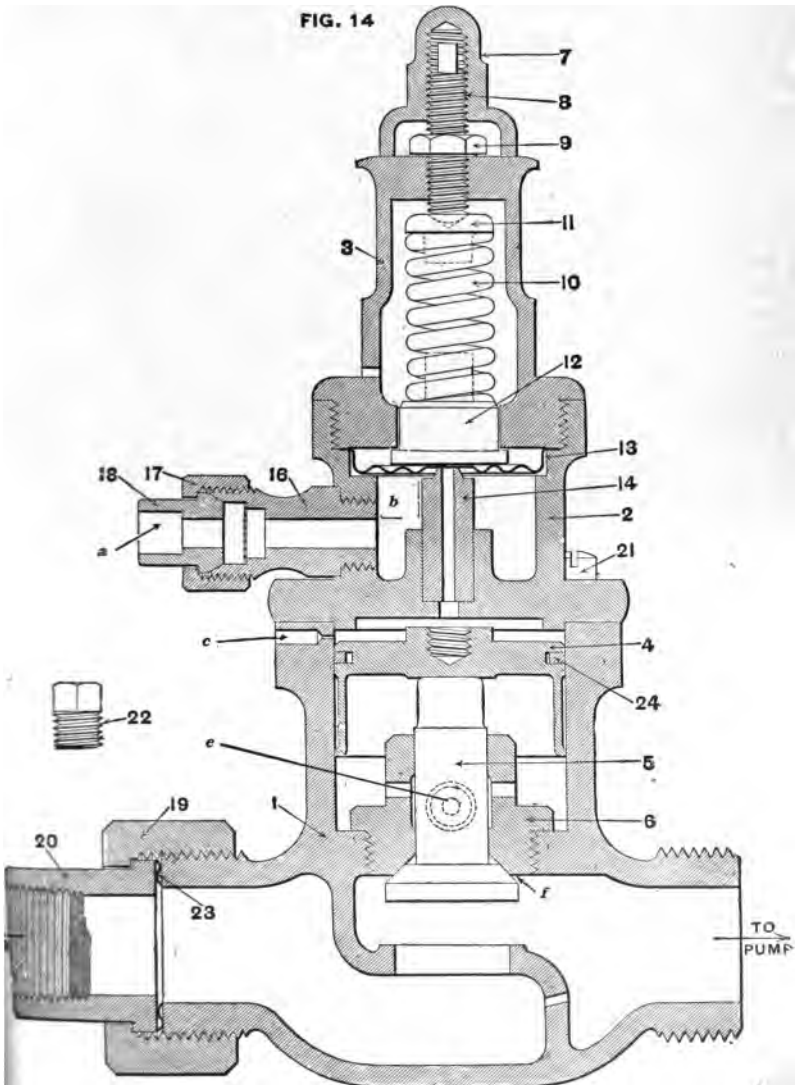
The Improved Westinghouse and New York Governors.—The Westinghouse and New York governors are identical in action, but some difference exists in their construction. The principal variances of the two are: (1) the Westinghouse pin valve *m* is discarded in the New York and in its place the diaphragm 13 acts as a valve on the valve seat 14 Figure 14. (2) the relief port *c* in the Westinghouse is moved to the side of the cylinder of the New York. (3) the piston spring of the Westinghouse is discarded in the New York, which depends entirely on the steam pressure to raise the steam valve.

"Old Style" Governor (Westinghouse).—In Figure 15 is shown an illustration of the *old style* Westinghouse governor. The principle of operation is identically the same as explained for the *Improved* and New York governors, except that there is no port *c* between the governor piston and the pin-valve, the air that is entrapped above the piston by the closing of the pin-valve, is supposed to leak down past the packing ring 24, which is purposely made to fit loose, and escape through the waste pipe stud 10.

The Improved governor, on account of the relief port *c*, enables it to start the pump much more promptly than the old one, as in two seconds after the pin-valve closes it releases sufficient air from above piston 28 to enable it to rise. The time re-

NEW YORK AIR PUMP GOVERNOR

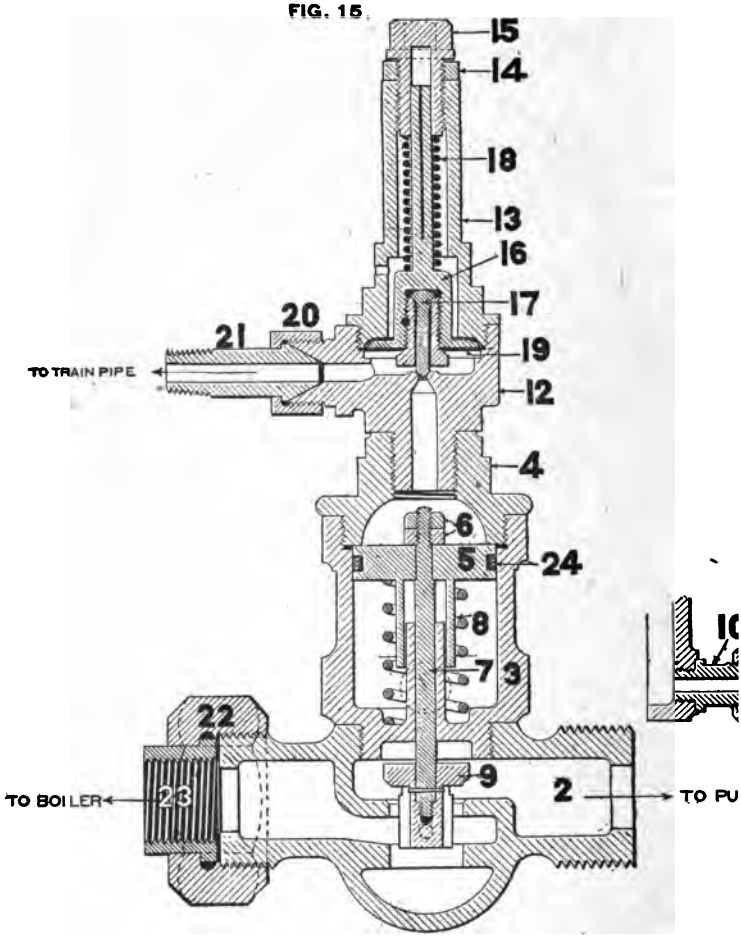
FIG. 14



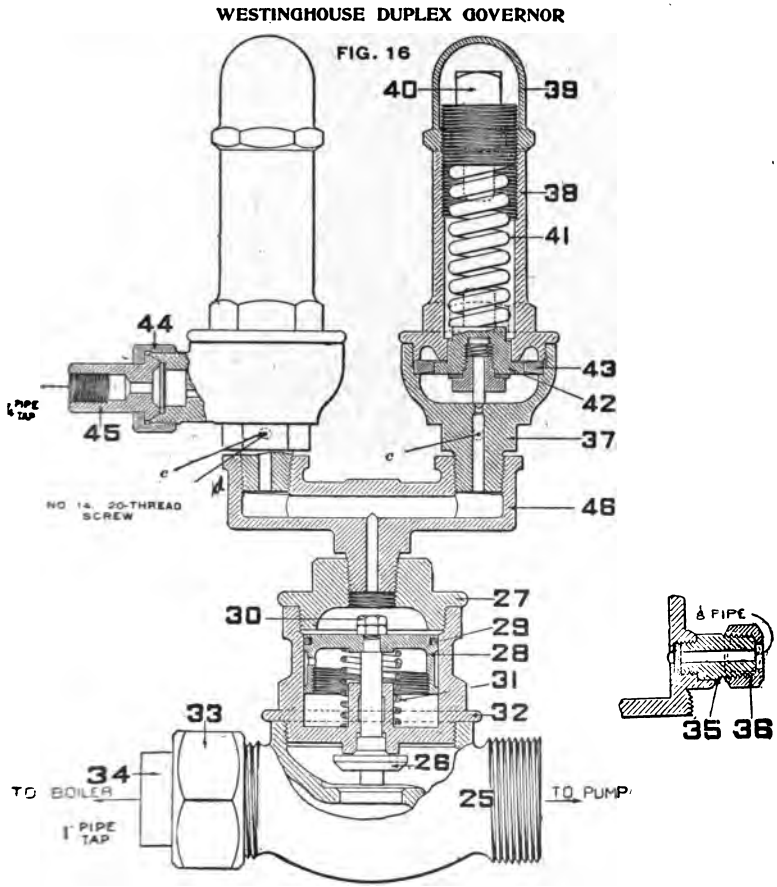
WESTINGHOUSE PUMP GOVERNOR.

(OLD STYLE

FIG. 15.



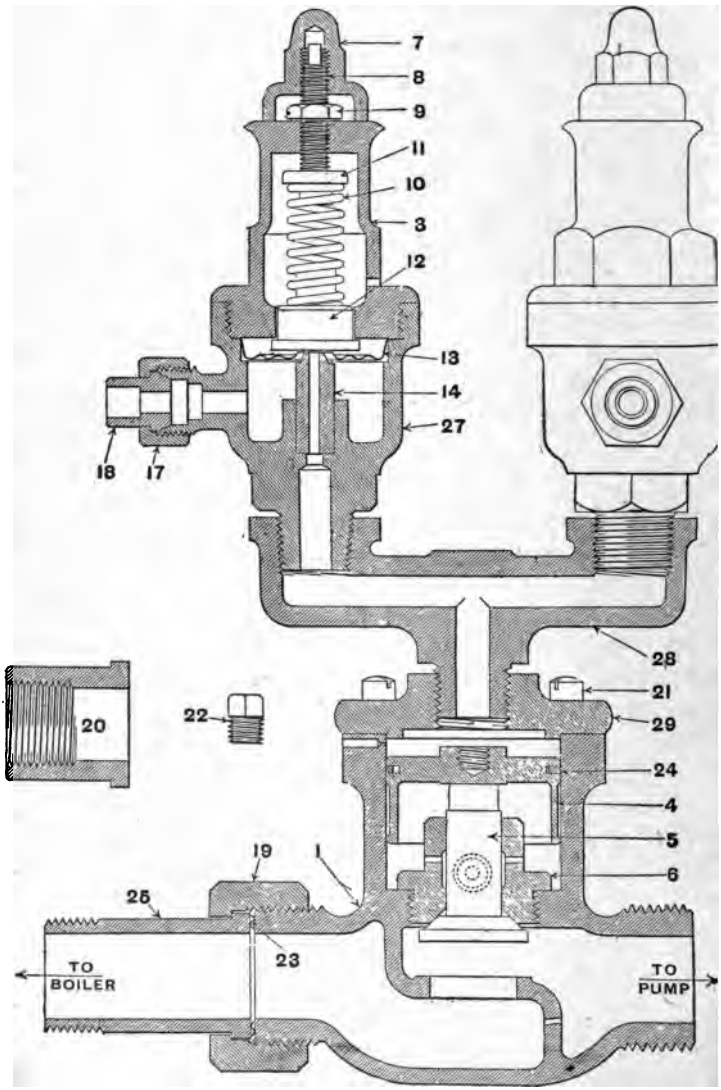
quired for the air to leak down past the packing ring of the piston 5 in the old governor in order



that the pump could go to work, varies very much, depending upon the fit made by the packing ring 24.

NEW YORK DUPLEX GOVERNOR

FIG. 17



Duplex Governor.—Sectional views of both the Westinghouse and New York duplex governors are given in Figures 16 and 17. Compare these with the ordinary governor. In reality a duplex governor is nothing more than two ordinary diaphragm bodies connected to one steam-valve body and operating in exactly the same way as the ordinary governor. But as one is usually set to operate at a higher pressure than the other only one of the diaphragms acts at a time. A cut out cock is placed in the pipe leading to the one set to work at the lowest pressure, so that when a higher pressure is desired, it can be quickly obtained by simply closing the cut out cock in the pipe leading to the low pressure governor top. The pump will continue to work until stopped by the other governor top. This duplex arrangement of the governor is usually used in connection with the High-Speed Brake and Special Apparatus for Governing Freight Trains on grades; also for level grade freight trains, enabling high excess to be accumulated while brake is applied and brake valve is on lap position. Lapping brake valve cuts out the low pressure governor. These arrangements will be explained under the head of special appliances to assist grade work.

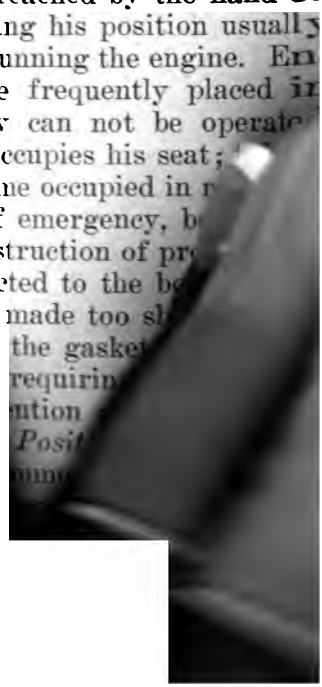
Where the duplex governor is used one of the relief ports *c* should be closed with a No. 14, 20-thread screw. (Figure 16.)

CHAPTER V.

ENGINEER'S BRAKE VALVE.

By the manipulation of this valve the engineer causes the brake to apply or release. It automatically performs another function with the brake-valve handle in the running position, by regulating the flow of air from the main reservoir to the train pipe.

Its Location in the engine cab should be as convenient as possible to be reached by the hand of the engineer without leaving his position usually occupied in the cab while running the engine. Engineer's brake valves are frequently placed in such a position that they can not be operated at all while the engineer occupies his seat; a serious neglect, as the time occupied in reaching the brake valve in case of emergency, be so little, may mean the destruction of pro loss of life. When connected to the bo the bracket should made too sh heat is liable to the gasket time, and dries th requirin receive more fre ution

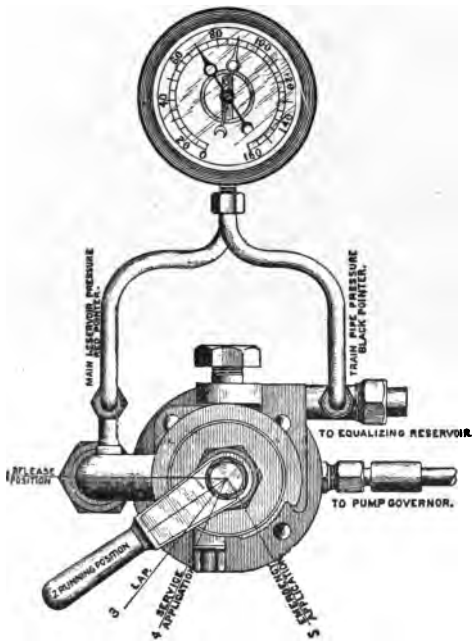


Brake Valve Posit brake valves no 5 positions in

(1) Release, (2) Running, (3) Lap, (4) Service and (5) Emergency. See Figures 18, 19 and 21.

Release Position.—This position opens direct communication between the main reservoir and

FIG. 18



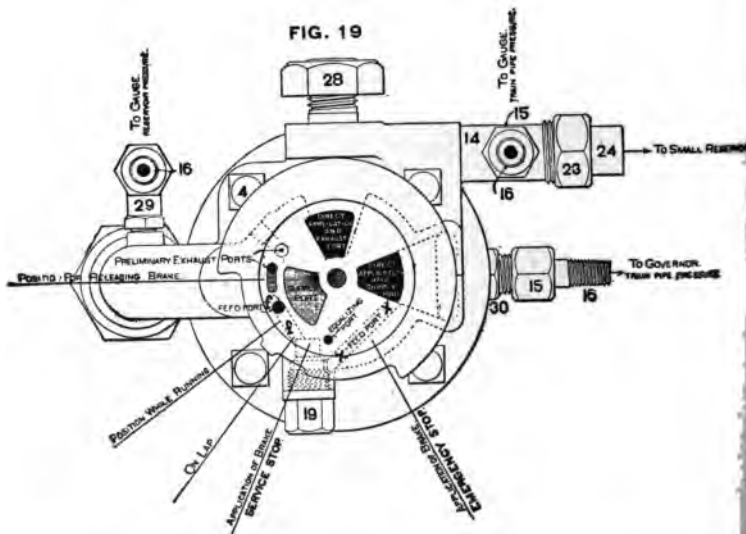
Engineer's Brake and Equalizing Discharge Valve and Duplex Air Gauge, known as the D 8 or 1889 Valve.

train-line and is used for releasing the brakes and to charge the train-line and auxiliary reservoirs quickly.

Running Position.—This is the position, the

brake is carried in, while running over the road with the brakes off. In this position there is an indirect communication between the main reservoir and train-line, air first having to pass through an excess pressure valve or feed-valve,

FIG. 19



for the purpose of maintaining an excess pressure in the main reservoir.

Lap Position.—In this position all ports in the engineer's brake valve are closed. This position is used between reductions in service applications to hold the brakes on when once applied and prevent more brake application than is desired.

Service Position.—This position is used in making a gradual or ordinary application of the brakes

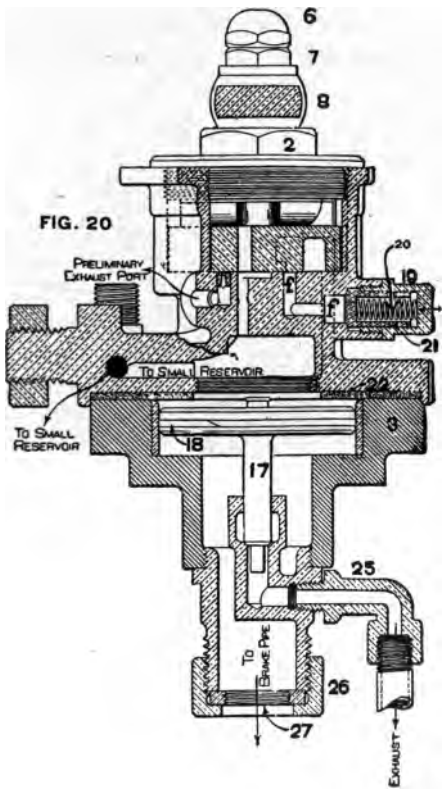


FIG. 20

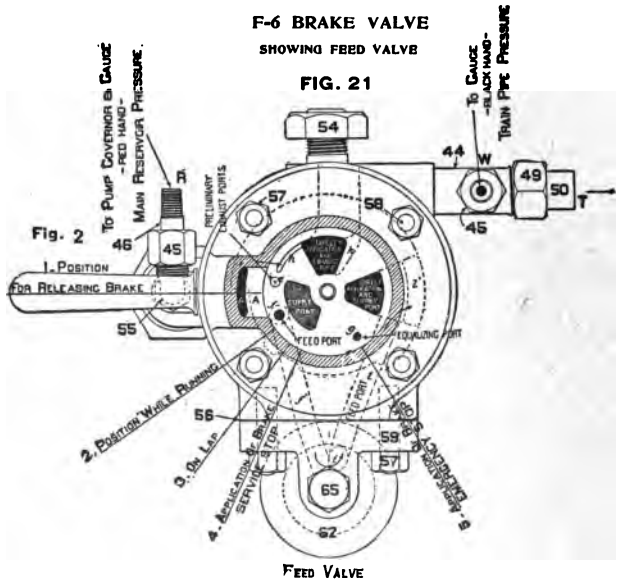
and is the only way in which brakes should be applied except in actual emergencies.

Emergency Position.—This position is used when it is desired to stop the train in the shortest

possible distance and should never be used except when life or property is endangered.

The D-8 Brake Valve.—(Figures 19 and 20.) Although this form of valve is gradually being supplanted by the F-6 (Figures 21 and 22) and

F-6 BRAKE VALVE
SHOWING FEED VALVE
FIG. 21

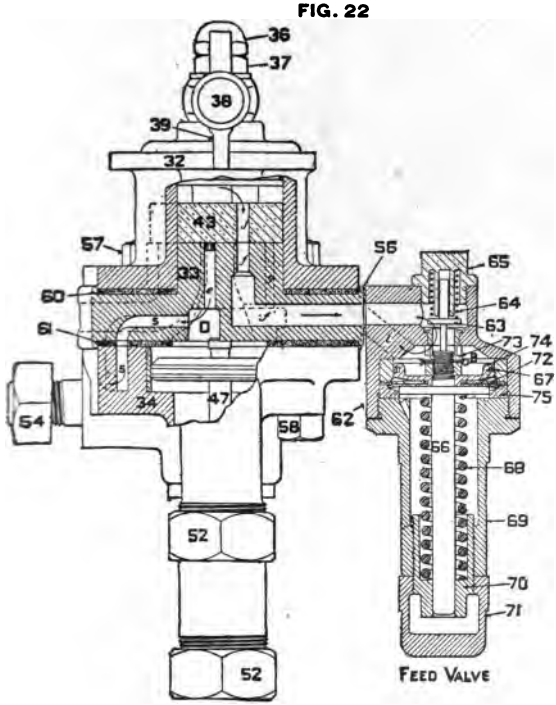

To Pump Governor & Gauge -Red Hand- Main Reservoir Pressure
To Gauge -Black Hand- Train Pipe Pressure
To Small Reservoir
Fig. 2
1. Position For Releasing Brake
2. Position While Running
3. On Lap
4. Application of Brake Service Stop
5. Emergency Position
Feed Port
Equalizing Port
Feed Valve

G-6 (Figures 23, 25 and 26) brake valves, there is still such a large number in use that it demands mention.

The only material difference between it and the latter forms of valves, F-6 and G-6, is that the old style feed-valve or slide-valve feed-valve is substituted for the excess-pressure valve. The

construction is so similar (the ports differing so slightly in form) that a lengthy description of all forms is not deemed necessary, the description

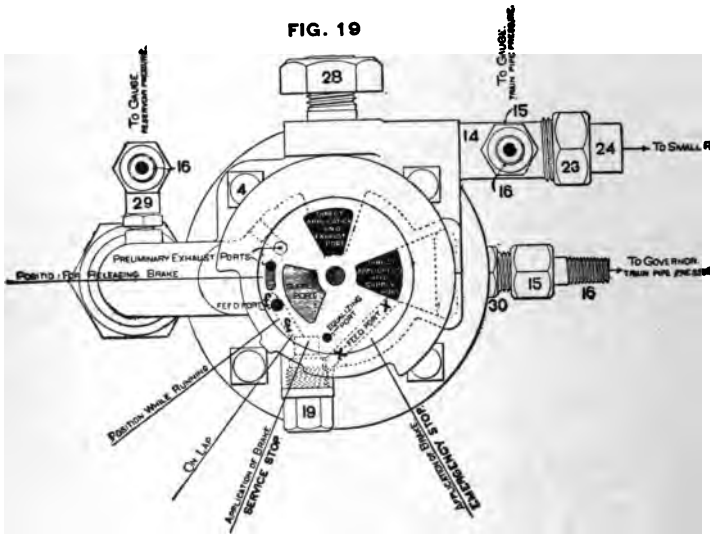
F-6 BRAKE VALVE WITH OLD STYLE FEED VALVE
RUNNING POSITION
FIG. 22



and plates of the F-6 or G-6 sufficing for all. Two sectional views (Figures 19 and 20), however, of the D-8 valve, showing the construction

brake is carried in, while running over the road with the brakes off. In this position there is an indirect communication between the main reservoir and train-line, air first having to pass through an excess pressure valve or feed-valve,

FIG. 19



for the purpose of maintaining an excess pressure in the main reservoir.

Lap Position.—In this position all ports in the engineer's brake valve are closed. This position is used between reductions in service applications to hold the brakes on when once applied and prevent more brake application than is desired.

Service Position.—This position is used in making a gradual or ordinary application of the brakes

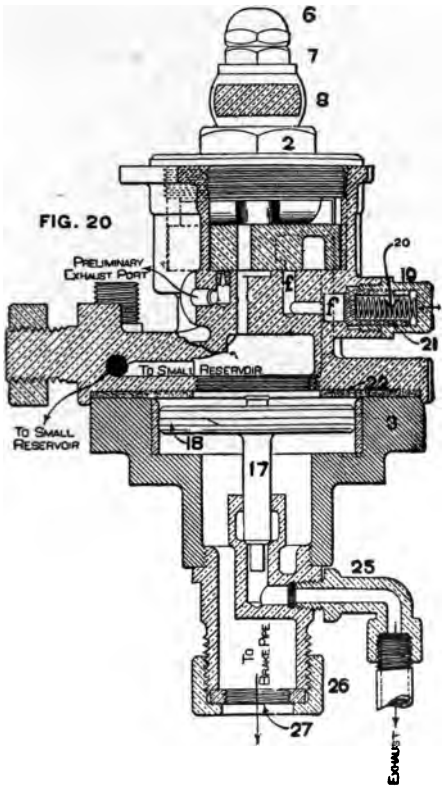


FIG. 20

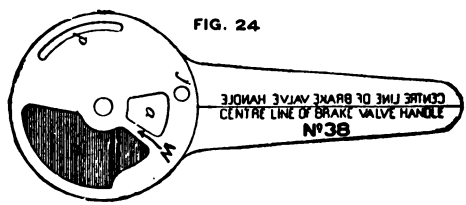
and is the only way in which brakes should be applied except in actual emergencies.

Emergency Position.—This position is used when it is desired to stop the train in the shortest

cause, so that it is less than 20 pounds in excess of that in the train line, with the brake hand in running position, the excess pressure valve practically "laps" the brake valve (prevents air air from the main reservoir reaching the train line) until the pump again accumulates the excess This results in brakes occasionally creeping when there is train line breakage.

The F-6 Brake Valve (Figures 21, 22 and 23). On account of having to refer to the feed-valve

FACE OF ROTARY VALVE
WITH HANDLE ATTACHED
FIG. 24



frequently while describing the construction and operation of this brake valve it is thought best to describe the feed-valve and its action before going into details of the valve proper.

Feed-Valve Attachment.—The feed-valve is often spoken of as the *train-line governor* which defines its function. The object of the feed-valve is to provide an open communication between the main reservoir and train-line, with the brake valve in running position, when the train-line pressure is below 70 pounds. (Or the standard at which the feed-valve is set to close.) The feed-valve was

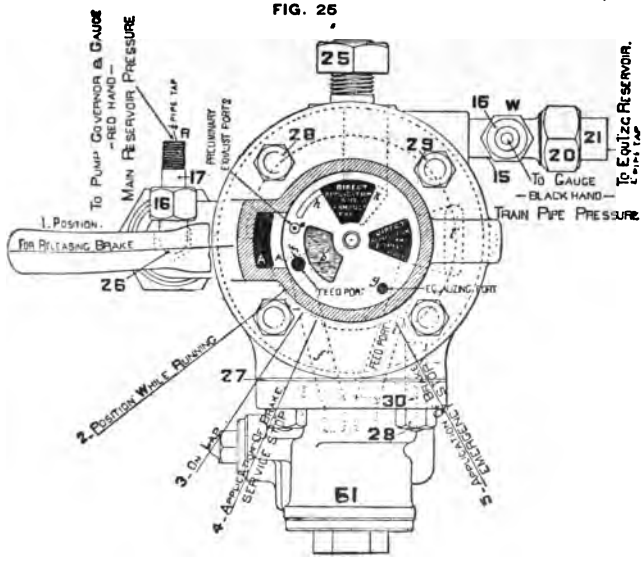
brought out by the Westinghouse Co. in 1892 in connection with the D-5 brake valve and later used on the F-6 brake valve; the prime object sought was to avoid the "false lap" that is peculiar to the excess pressure valve.

Figures 21, 22 and 22-A show the feed-valve;

G-6 BRAKE VALVE

PLAN OF PORTS

FIG. 25



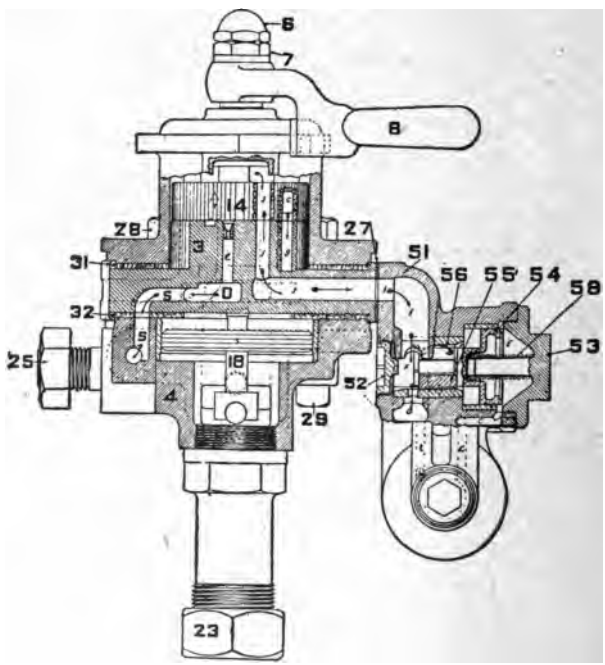
68 is the regulating spring which exerts an upward pressure on the feed-valve piston 74, the upward pressure or tension of the spring is regulated by means of the regulating nut 70. Screwing up the nut increases the tension of the spring and un-

screwing or screwing down the nut decreases its tension. The tension of this spring is what determines the amount of train-line pressure to be car-

G-6 BRAKE VALVE

RUNNING POSITION

FIG. 26



ried. The lower stem of the supply valve 63 rests on the upper portion of the feed-valve piston stem 66, and is held there firmly by the spring 64, so that any movement made by the feed-valve piston

66 either up or down, the supply valve 63 also makes. The supply valve 63 remains off its seat and approximately in the position shown in Figure 22 until pressure in the main reservoir reaches 70 pounds. We will now presume the pump is started with the brake handle in running position, the supply valve 63 being off its seat, there is a direct communication between the main reservoir and train-line past valve 63, therefore the pressure in both rises at the same time; both hands of the air gauge start up together. Main reservoir pressure comes to the feed-valve through port *f* and feeds by the supply valve 63. As soon as it passes this valve into port *i* it is considered train-line pressure. If the tension of the spring 68 is set at 70 pounds, as soon as 70 pounds air pressure is attained in chamber B the pressure bearing down on piston 74 compresses the spring 68, and allows the supply valve 63 to close. (Figure 22-A.) No more pressure from the main reservoir can get into the train-line and the train-line hand of the gauge stops going up. But the pump governor being regulated by main reservoir pressure and set at 90 pounds or more the pump continues to work and compress air into the main reservoir until that pressure is accumulated; the main reservoir hand of the air gauge rising to the amount mentioned. Should the pressure in the train line above piston 74 become reduced through leakage, the spring 68 forces the valve 63 from its seat (Figure 22) and pressure in port *f* from the main reservoir again flows in the train-line through

port *i*. Should the pressure in the train-line be reduced by making an application of the brakes, the valve 63 is forced from its seat just the same, but main reservoir pressure cannot get by the rotary of the brake valve into port *f* until the brake handle is returned to either release or running position. Thus as long as train-pipe pressure in chamber B is less than 70 pounds, the spring 68 will hold the communication between main reservoir and train-line open, but as soon as the train-line in chamber B reaches or exceeds 70 pounds it closes communication between the two as long as the brake handle remains in running position.

Release Position.—The position of the brake valve is shown in Figure 23 in release position. In this position the supply port *a* of the rotary (Figure 24) stands directly over the cavity *b* of the rotary seat, and port *j* of the rotary (see Figures 23 and 24) is directly over the preliminary exhaust port *e* (see Figures 21, 23 and 25). Now by referring to Figure 23 it will be seen that main reservoir pressure is free to pass up from the main reservoir through the pipe marked *To Main Reservoir* and passage *A, A,* then down into supply port *a, b,* where the passage appears to end, but such is not the case. The narrow bridge w of the rotary Figure 24 stands across the middle of the cavity *b,* so that the air in it enters cavity *b,* passes under the bridge and up into cavity *c,* thus into direct application port *l, l',* to train-line connected at Y. While the air is passing through

cavity *c* to the train-line a portion of it feeds down through the equalizing port *g* (see Figures 21, 22, 23) into chamber D, where it is in direct communication with the equalizing reservoir through the port *s*. (In speaking of air pressure in chamber D it must always be borne in mind that the equalizing reservoir [see plate G-1, appendix] is really a part of chamber D, the only purpose of the equalizing reservoir being to enlarge the chamber D; therefore in this article air will be only spoken of as in, from, or to, chamber D.) While the brake handle is in release position air from the main reservoir is also free to feed down through port *j* of the rotary and the preliminary exhaust port *e* in its seat into chamber D. Thus we see in release position there is *one large* port directly connecting the main reservoir and train-line, and *two small* ones leading to chamber D.

By reference to Figure 23 a very small port *r* will be noticed. This little port is directly over the emergency exhaust port *k* in the rotary seat Figure 25 when the brake handle is in release. Main reservoir pressure blowing through it into the empty emergency port, which is open at the atmosphere, makes a distinct "hiss" and annoying noise. This is called the *warning port*, reminding the engineer that his brake handle is in full release and if he allows it to remain there too long the train-line and auxiliaries will be overcharged to the pressure carried in the main reservoir. If the engineer allows this to be done he will experience trouble in the following ways: (1) If he

returns the brake handle to running position with train line and auxiliaries overcharged the feed valve will remain closed until the train-line pressure is reduced below 70 pounds, consequently train-line pressure leaking away, may cause the brakes to "creep on"; (2) The auxiliaries being overcharged to so high a pressure might cause the wheels to slide and flat spots be the result; (3) When it would be desired to release the brakes trouble would be experienced on account of the lack of excess pressure, as some of the brakes would probably not release.

Running Position.—With the brake valve in this position there is an indirect passage for the air from the main reservoir to the train-line through the brake valve, all the air having to pass through the feed-valve (Figure 22). Air from the main reservoir being on top of the rotary, feeds down through port *j* of the rotary, which is directly over the port *f*, in the seat, that leads to the feed-valve through passage *f*, and once it has passed the supply valve 63 of the feed-valve it is considered train-line air, as this is the separating valve between main reservoir and train-line air. Thus the air from the main reservoir continues to flow into the train-line through this valve which remains open until 70 pounds pressure is obtained, when it closes and remains so until train line pressure reduces a trifle less than 70 pounds, when it opens just long enough to restore the pressure and closes again (as explained under the head of the Feed-Valve Attachment). In running posi-

(Figures 22, 26) chamber D and the train-line always in communication through port *g*, h leads from chamber D up into the cavity *C* e rotary, which is subject to train-pipe pres- in this position. This causes an even pres- to exist above and below the equalizing pis- 47 or 18 (Figure 23), the stem of which is on the train-line exhaust E by its own ght.

ip Position.—With the brake handles in this tion, all ports and passages are closed, the e pressures—main reservoir, train-line and nber D—being entirely separate from one an- r.

ervice Position.—With the brake handles in position the rotary has been moved so that long narrow groove *p* (see Figure 24) com- icates port *e* with the port *h* (Figures 21, 25), h is grooved out so as to connect it with the t-application-and-exhaust port K, the latter g open to the atmosphere. A direct passage for ir is thus established from chamber D (Figure o the atmosphere (all other ports and passages g blanked, main reservoir pressure cannot get he rotary into the train-line or chamber D). air in chamber D above piston 18 is reduced in ce position, the amount desired by the engi- and the valve placed on lap; the higher pres- in the train-line below the piston forces it This opens the train-line air to escape through age *m*, E, *n*, E-*l* (Figure 23) to the atmos- e until the air in the train-line has been re-

duced a trifle less than the pressure left in chamber D, when the piston 47 or 18 drops or is forced by the pressure in chamber D to its seat, closing the train-line exhaust E. (Before the pressure, however, in the train-line will reduce equal to that in the chamber D*, it is understood the brake valve must be returned to lap position; for if the brake handle is allowed to remain in service position the air in chamber D will continue to escape to the atmosphere faster than the air in the train-line. So in describing the action of piston 47 or 18 it must be inferred that the brake handle was returned to lap after any desired reduction before all the air from chamber D escaped.)

Now if it should be desired to apply the brake harder, the rotary is again placed in service position and the events just described will occur again. The manner just explained of how the air in the train-line is reduced proves that the engineer does not directly let the air out of the train-line, but simply lets a little air out of chamber D which causes the piston 47 or 18 to rise and it (the piston) automatically lets the air out of the train-line and gradually closes it again.

This gradual closing feature is the object of the equalizing piston without which it would require a great deal more skill, patience and careful handling of the brake valve by the engineer.

Emergency Position.—When the brake valves are moved to this position the cavity *c* in the

*Chamber D reduces from 70 to 50 pounds in about 5 to seconds.

ry connects the direct-application-and-supply
l, which leads to the train-line, with the
t-application-and-exhaust port *k* that leads to
tmosphere; these ports all being large, cause
dden heavy full train-line reduction, conse-
tly all triple valves go into emergency action,
applying the brakes rapidly to their greatest
ity.

e G-6 Brake Valve (Plate G-6, Appendix).—
is the latest form of brake-valve introduced
e Westinghouse Air Brake Co. It differs only
the other form (F-6) by the substitution of
lide valve feed-valve in place of the *feed-*
attachment described. The two feed-valves
nterchangeable. As the F-6 brake valve has
fully described, a description of the opera-
of the G-6 brake-valve would only be a reprint
e same words. The *slide-valve feed-valve* of
-6 brake-valve is differently constructed than
eed-valve attachment of the former, although
rforms the same function and it does it far
r.

de-Valve Feed-Valve.—As is explained else-
e the F-6 feed-valve attachment works per-
where the train-line is free from any serious
or on short trains, as in passenger service;
ith long freight trains it exposed a weakness.
s to overcome this fault that the slide-valve
alve was brought out. Figures 26, 28,
the slide-valve feed-valve with an inte-
view of the upper portion of the feed-
As the lower portion stands at right angles

with the upper portion, another view (Figure 27) shows the interior of the lower portion. On account of the two portions standing at right angles it is difficult to clearly explain its workings and for the reader to trace the ports and air passages, a twisted view of both sections is shown

SLIDE VALVE FEED VALVE

FIG. 27

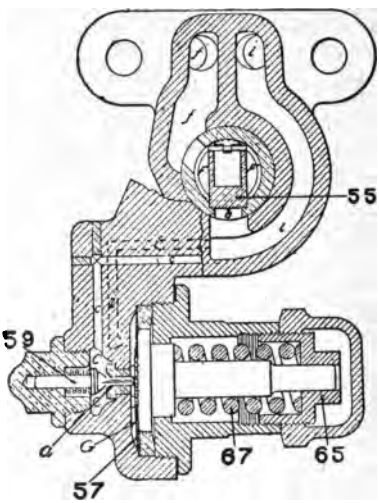
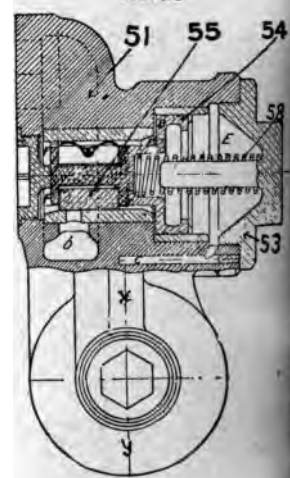


FIG. 28



in Figures 29 and 30. The air passages leading from one portion of the valve to the other are so arranged that they can be easily traced. The upper portion has a slide-valve 55 to open and close the air supply port *b*, and allow the air to pass from the main reservoir to the train pipe when the rotary is in running position. This supply valve is operated by a piston 54 which is moved

e direction by the main reservoir air pres-
in the other by a spring 58.
e lower portion has a diaphragm 57 which
sts of two thin brass sheets similar to the
nor diaphragm, keeps the train pipe air
escaping to the atmosphere through the

SLIDE VALVE FEED VALVE

FIG. 29

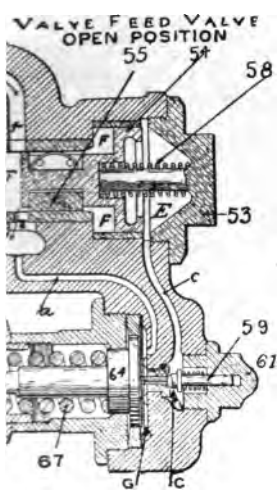
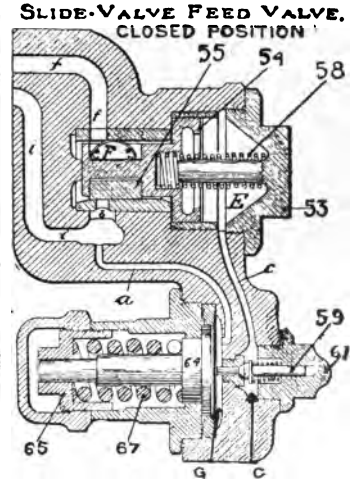


FIG. 30



g case; this diaphragm rests on a piston 64
ı is held up by the regulating spring 67.
stem of the regulating valve 59 rests
st this diaphragm; when 57 moves over the
ating valve moves with it.
e the plain feed-valve, port *f* is the inlet from
ıain reservoir and port *i* the outlet to the
line. The lower portion of the valve as

shown in Figures 27, 29, is the same in operation as the plain feed-valve; the slide-valve feed-valve consists of the slide-valve arrangement placed so that main reservoir air must pass through it before reaching the feed-valve. After reaching the feed-valve port the air does not return to the slide-valve again, but goes directly to the train-line through the passage *i, i, i*. The position of the slide-valve shown in Figures 28, 30 is the position the spring 58 holds it when there is no air pressure in the system. We will now suppose the pump is started with the brake handle in running position. Main reservoir air passes through port *f*, fills the chamber F, and pushes piston 54 to the right, compressing spring 58; it draws with it the small slide-valve 55, which uncovers the port in its seat, permitting the pressure to pass down into chamber B (Figure 29), which is in direct communication with the train-line through passage *i, i, i*, thus allowing the main reservoir air to feed unobstructed into the train-line.

Now piston 54, although a neat fit in its cylinder, has no packing ring, so there is a slight leak past it from chamber F into chamber E, which passes down through port *c* into chamber C, thence under the open regulating valve of the feed-valve into chamber G and port *a*, assisting to charge the train line. We now see that before the pump has accumulated 70 pounds pressure, air from the main reservoir reaches the train-line in two ways, direct and indirect. As was explained in the article on feed valve attachment, train-line air is con-

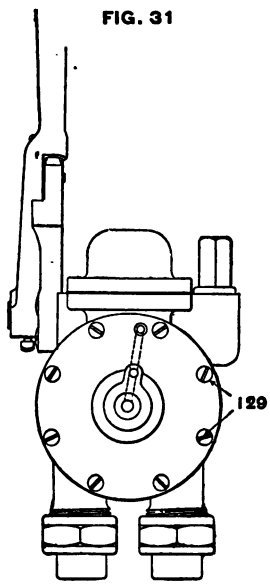
ıtly in chamber G, and when it reaches 70 ınds pressure it compresses regulating spring by its action on the diaphragm 57; supply valve closes, the indirect supply from the main res- oir to the train-line is closed. As the air still ıtinues to leak past the piston 54 into chamber which now has no outlet, the pressure instantly omes the same on both sides of piston 54, and spring 58 moves it to the left together with the le-valve 55 (see Figures 28, 30). This closes direct passage of air from the main reservoir train-line, both passages being closed the train- e pressure is not increased beyond 70 pounds, t the pump still continues to work until 90 unds or more is accumulated in the main res- oir. We will now suppose train-line pressure omes reduced below 70 pounds through leak- : spring 67 raises valve 59 from its seat and ows the pressure accumulated in chamber E reduce and equalize with the train-line. The ssure in the chamber F now being more than pounds greater, moves the piston and slide- lve to the right, uncovering the slide-valve port ınd again opening the direct passage for air m the main reservoir to feed into the train-line l raise the pressure to 70 pounds, again closing previously described.

New York Brake Valve (1902 Model).—The ac- ıpanying figures illustrate the improved brake ve which is known as the R-3 1902 model. This ve retains in its construction all the essential tures of its predecessor, known as the Vaughan

McKee brake valve (Plate Q-3, Appendix), a possesses in addition several modifications o working parts which make it completely matic. This valve works similar to the Wes house, with the exception that in service ap tion it does not need to be "lapped." The automatically "laps" itself.

Figures 31 and 32 are external views—rea and side respectively. Figure 33 is a cross se through the excess pressure valve (rear v Figure 34 is a section through the side, sho travel of slide-valve 1 and how the gradu valve 110 is controlled b piston 104-A. Figure a cross section throug slide-valve (front view). ure 36 is a plan of the seat. Figure 37 show face of the slide-valve.

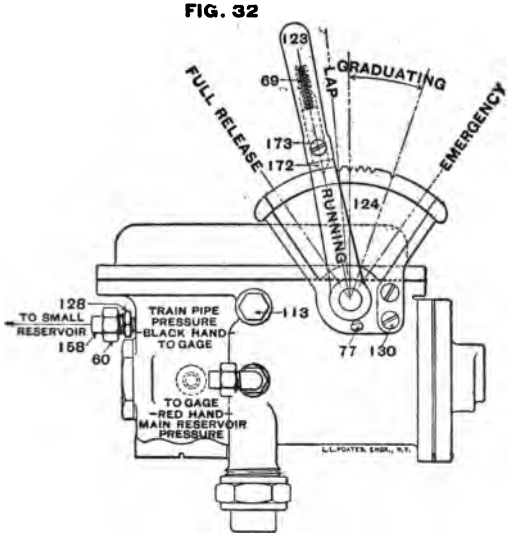
NEW YORK BRAKE VALVE
FIG. 31



The Principal Parts Their Duties.—Referri Figure 34 the main rese air is connected to cha B; the train pipe is connected to cha A. The discharge of pipe air to the atmosp for service application curs through ports F and passage C. Main valve 114-A controls the flow of air from main reservoir to the train pipe and fron

train pipe to the atmosphere. A service application uncovers small ports of slide-valve F and G. An emergency application uncovers large ports K and J (see Figures 35 and 37). Small slide-valve 110 is a cut-off, or graduating valve, held up by a spring, making a seat on the under side of slide-

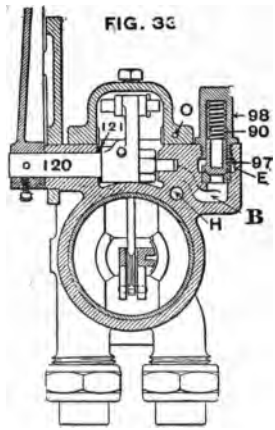
NEW YORK BRAKE VALVE
FIG. 32



valve 114-A. This small graduating valve is operated by the lever 112, which connects to piston 104-A. This piston has a packing leather and a ring to make an air-tight joint on the walls of the cylinder in which it works. The piston is exposed on one side to train pipe air, contained in chamber A, and on the other side to chamber D, to which the

supplementary reservoir is connected. This p
ton causes valve 110 to move automatically wh
ever distance is necessary to close port F. A
crease of train-pipe pressu
in chamber A, when caus
by placing the brake han
in a service applicati
allows the air contained
the supplementary reserv
and chamber D to expar
and thus move the pist
toward the opposite end
the cylinder in which
works. This causes the lev
112 to move the cut-off val
110 far enough to close p
F by moving in the opposi
direction as far as port F h
been carried by the slide-valve. The reduction
train-pipe corresponds to the distance the cut-
valve is required to move to close port F. Passa
H runs lengthwise of the brake valve as indicat
and connects the supplementary reservoir with t
chamber D, back of piston 104-A.

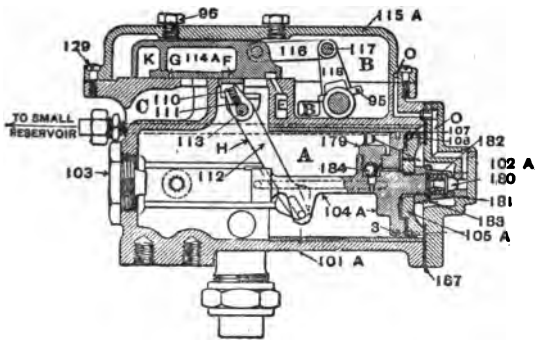
NEW YORK BRAKE VALVE
FIG. 33



Modifications.—There are two modifications
this (1902 model) brake valve which improve
over the operation of the Q-3 brake valve. (
The ball check valve 184 has been placed in t
piston 104-A. This allows air from the train-pi
side of the piston to pass freely into the supp
mentary reservoir via chamber D and passage
but prevents any backward flow of air to the tr

pipe. (2) Vent valve 180 has been attached to the end of the piston stem. This valve controls the passage O leading to a port in the valve seat, which is opened to the atmosphere by means of port J and exhaust port C in "Release" position, and by means of cavity P and exhaust port C in "Running" and "Lap" positions, but being blanked in all other positions. Should anything

NEW YORK BRAKE VALVE
FIG. 34

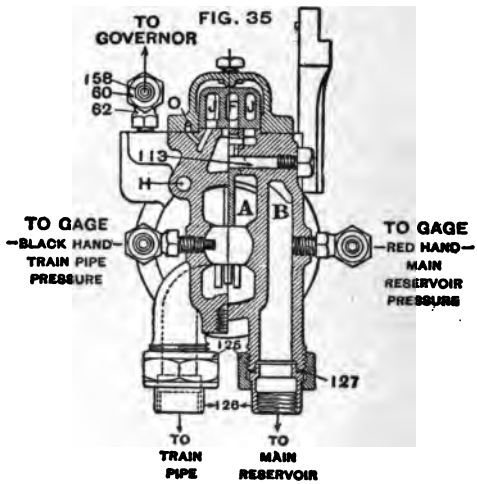


cause piston 104-A to be moved forward when brake-valve is not in one of the positions for applying brakes, chamber D is instantly opened to the atmosphere via valve 180, and train-pipe air promptly pushes piston 104-A back to a normal position.

The pressure of air in chamber D and supplementary reservoir is no longer under control of the main slide-valve, as was the case in the former valve Q-3, but is now always the same as train-pipe pressure, practically speaking, as when brakes are

applied chamber D expands to equal train-pipe pressure and when brakes are released only air enough is discharged by the slide-valve from chamber D to cause the return of piston 104-A. In slide-valve 114-A port J is made shorter and is no longer used as an equalizing passage between train-pipe and supplementary reservoir.

NEW YORK BRAKE VALVE



Operation.—The New York brake valve handle has five positions, i. e.: "Release," "Running," "Lap," "Service," and "Emergency." The "Service" position is sub-divided into five graduating notches. Piston 104-A and slide-valve 110 assume a position after a service reduction which is termed "Automatic Lap." (*Note.*—In each of the illustrations notice the combination of

the slide valve and seat just above the figure. The dark portions show the ports that are open.)

Release Position.—When the handle is placed in the extreme forward position (Figure 38), the rear edge of slide valve 114-A uncovers port A in the seat. Thus main reservoir air is free to flow to chamber A and train-pipe, releasing the brakes and charging the auxiliaries. At the same time a small quantity of air contained in chamber D is discharged to the atmosphere through ports O and J, and passage C, thus allowing train-pipe pressure to push piston 104-A and cut-off valve 110 to the position shown, in readiness for a service application. When the piston makes its full travel, vent valve closes port O, preventing any further reduction of chamber D, while check-valve 184 allows chamber A to charge chamber D equal to the train-pipe pressure. In this position main reservoir, train-pipe and chamber D pressures equalize.

NEW YORK BRAKE VALVE

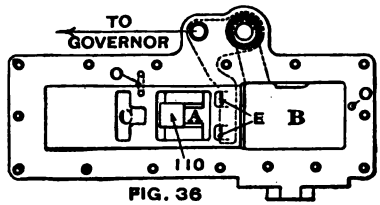
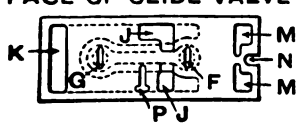


FIG. 36

NEW YORK BRAKE VALVE

FIG. 37

FACE OF SLIDE VALVE



Running Position.—When the handle is placed in running position (Figure 39), the main slide-

FIG. 38

N. Y. BRAKE VALVE, RELEASE POSITION

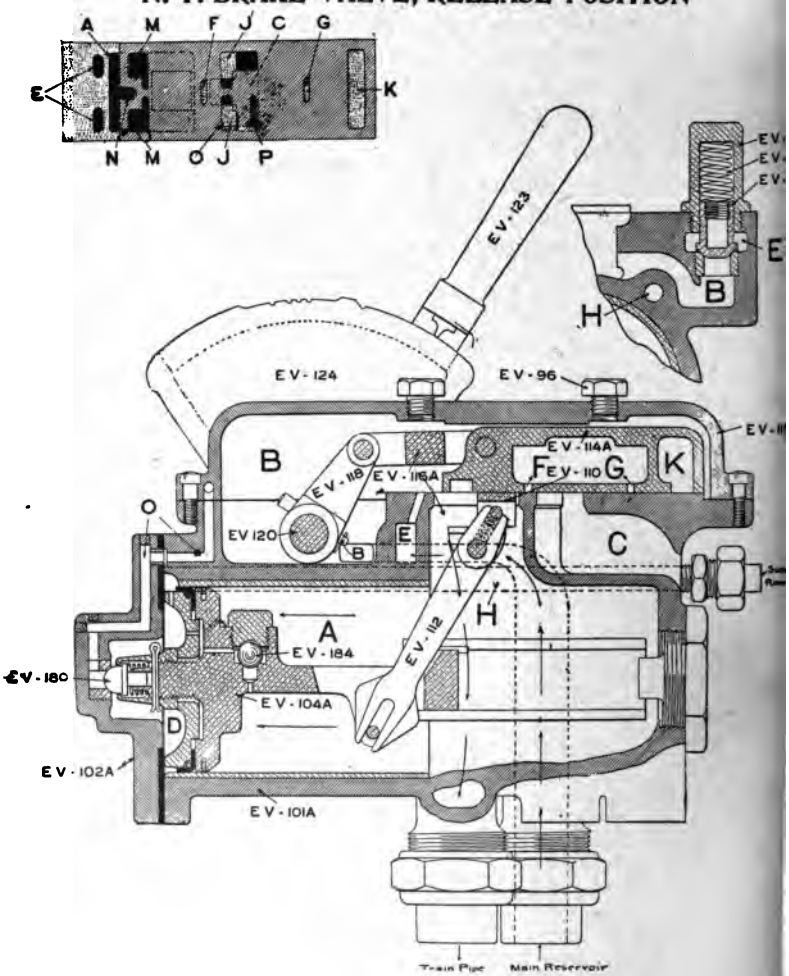
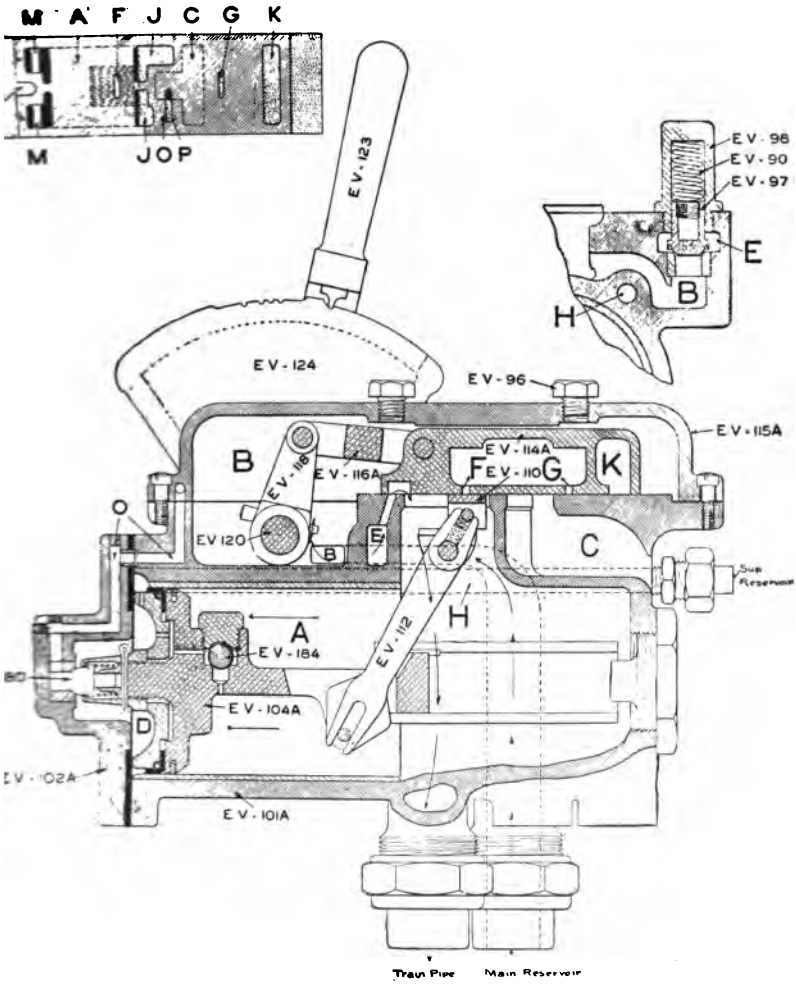


FIG. 39

N. Y. BRAKE VALVE, RUNNING POSITION



valve covers port A in its seat. Main reservoir air flows by the excess pressure valve 97 (shown above Figure 39, also shown in Figure 33) through port E and cavity M of slide valve to chamber A and train pipe. Valve 97 is for the purpose of maintaining excess pressure (the amount depending on the tension of the spring 90). It will be noticed that this valve is constructed like a pop valve—there is a flange or projection on it, so that when it lifts from its seat air may work on this flange, thus raising the valve higher from its seat and permitting a faster feed to the train pipe.

Lap Position.—When the handle is moved to position shown in Figure 40 the slide valve blanks all communication between the main and train pipe and between the train pipe and atmosphere.

Service Application.—Each notch of the five sub-divisions is used in accordance to the amount of reduction desired. Figure 41 shows the handle in the third notch, the main slide valve is moved back until port F in its face is uncovered, and port G, which communicates with port F, is brought over port C, which leads to the atmosphere. The arrows will show the course the train-pipe air takes in passing out. It is not now necessary to return the handle to "lap." On account of port O being blanked and the passage through piston 104-A being blocked by valve 184, the air in the chamber D and the supplementary reservoir will begin to expand and push the piston forward as fast as the train pipe pressure reduces in chamber A in front

FIG. 40

N. Y. BRAKE VALVE, LAP POSITION

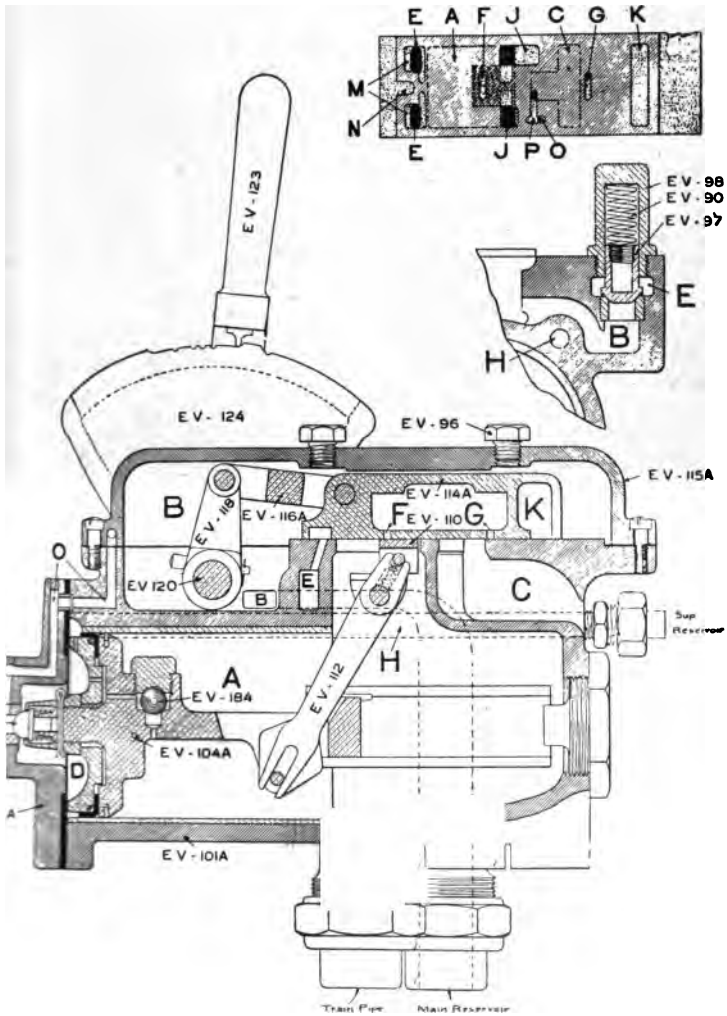
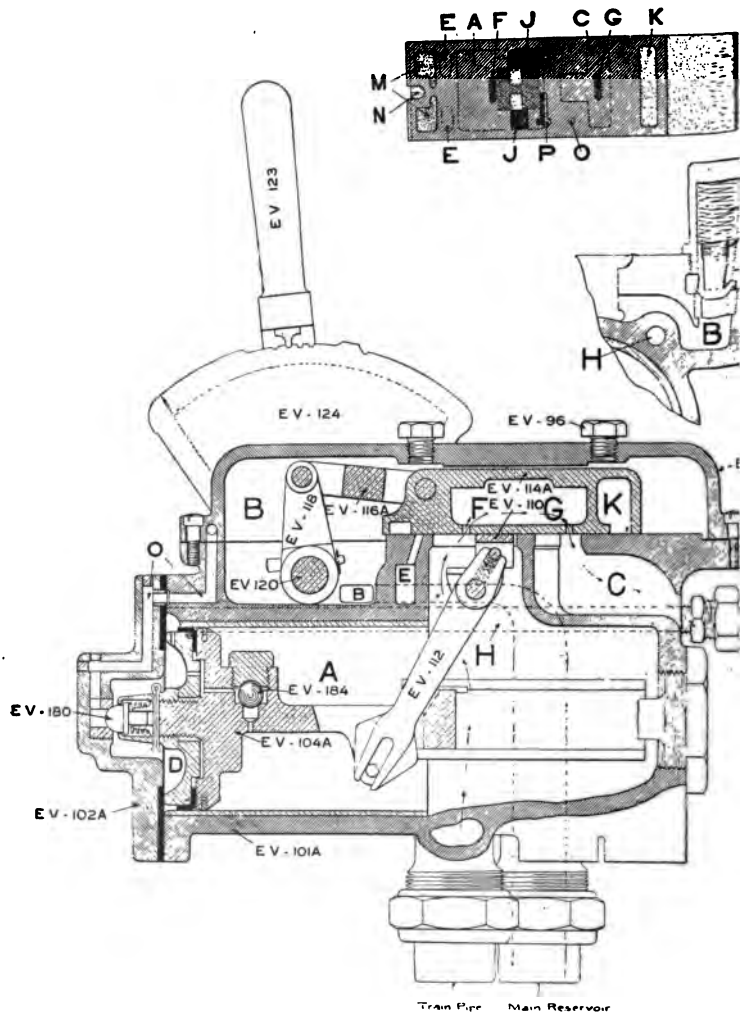


FIG. 41

N. Y. BRAKE VALVE, SERVICE POSITION



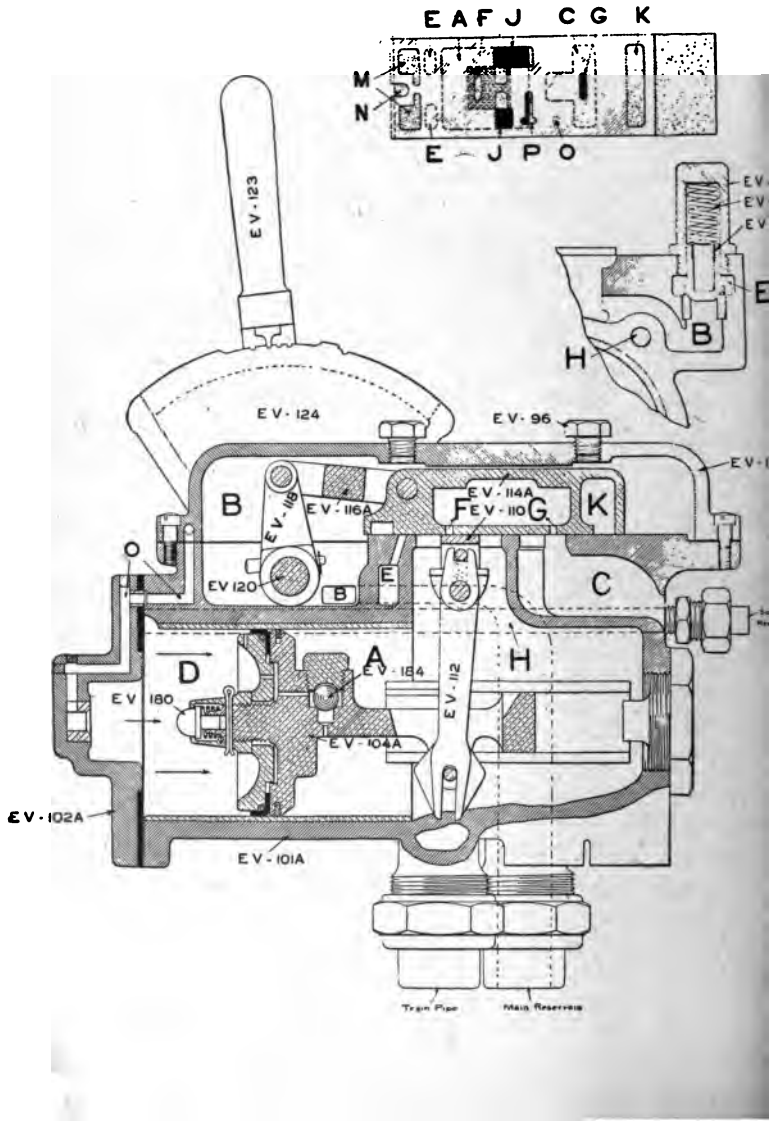
of it. When the piston moves the cut-off valve 110 far enough to close port F again, it prevents a further reduction of train pipe pressure. (See Figure 42.) If the handle is moved back another notch, again port F is opened, again train pipe pressure is reduced until chamber D expands enough to again close the cut-off valve 110.

Automatic Lap (Figure 42).—The stroke or travel of the piston is governed by the expansion of the volume of air in the supplementary reservoir. The more compressed air expands, the lower the pressure becomes. Therefore, supposing a reduction of ten pounds is made in the train-pipe, the piston moves to the right, allowing the air in chamber D to expand till it becomes reduced ten pounds; also when the pressure becomes equal the piston stops. This explains *why* the piston stops at a certain place each time the brake handle is moved a graduating notch; when the piston has moved to the right its extreme travel the pressure in the chamber D and reservoir has reduced about twenty pounds, thus it must be clear that the train-pipe must have first been reduced twenty-five pounds, which reduction would apply the brakes in full.

Emergency Position.—The handle is back as far as possible. Figure 43 shows how the slide-valve allows train-pipe air to leave quickly through large ports J and K and by means of a passage through the main slide-valve connecting these ports and the exhaust port C to the atmosphere. This sudden reduction starts the quick action parts of the

FIG. 42

N. Y. BRAKE VALVE, AUTOMATIC LAP POSITION



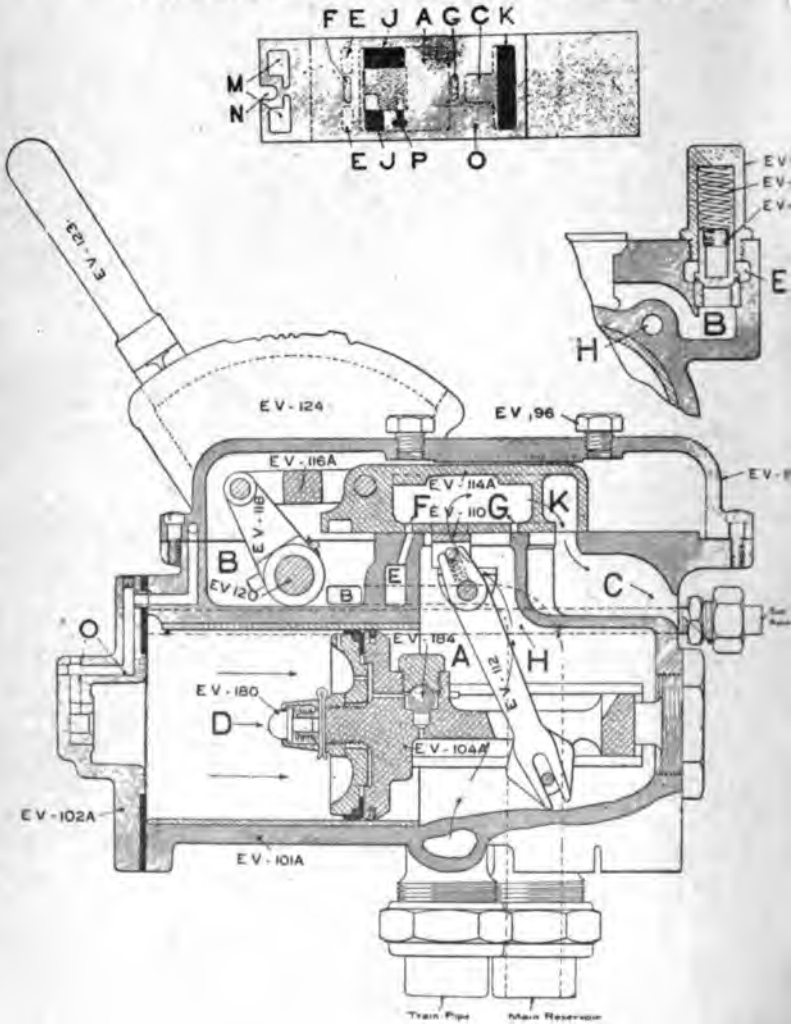
triple valves. To release the brake see "Release Position." Oil plugs 96 can be removed to place a small quantity of oil on the slide-valve when necessary.

The Single Governor is usually set at 70 pounds and should always be connected to the passage E in front of the feed-valve, as shown in Figure 5. If handle is carried in release position only 70 pounds will be accumulated in main reservoir and train-pipe, and overcharging cannot occur. In all other positions of the handle, air from the main reservoir has to pass the feed-valve before going to the governor, and, consequently, there will be an excess of pressure in the main reservoir, determined by the feed-valve spring, which is usually set at 20 pounds. The single governor is adapted for general service where long trains are not handled.

The Duplex Governor, for the single-pressure system, has the low-pressure top connected direct to the train-pipe above the cut-out cock, usually to a tee inserted in the gauge pipe; and the high-pressure top connected direct to the main reservoir, either to a tee in the gauge pipe or to a convenient point in the main reservoir as far as possible from the air pump discharge pipe. The governor connection forward of the feed-valve must be plugged. This arrangement possesses all the advantages of the single governor, connected as described above, and in addition permits the accumulation of any desired excess in the main reservoir while brakes are applied, without requir-

FIG. 43

N. Y. BRAKE VALVE, EMERGENCY POSITION



ing the pump to work against a high pressure when brakes are released, a marked advantage in handling heavy trains.*

*For other "governor arrangements" see Section *Special appliances for aiding in handling heavy freight trains on grades.*

CHAPTER VI.

THE MAIN RESERVOIR.

(Plates G-23 and Q-18, Appendix.)

The principal object of the Main Reservoir is to store an abundant air supply for the purpose of releasing and quickly recharging the brakes; but it also serves to entrap any dirt and water suspended in the compressed air, and to thereby prevent their being conveyed into the brake system.

The Main Reservoir should have a capacity of not less than 25,000 cubic inches (and often more) upon passenger engines (from the fact that passenger engines are used occasionally on freight trains), and not less than 40,000 cubic inches on freight engines—50,000 to 60,000 is better. The use of a large reservoir in freight service is of great benefit to the air pump, as it permits a sufficient volume of air to be compressed while the brakes are applied to release the brakes and recharge the auxiliary reservoirs without running the pump at a high rate of speed for that purpose, which would entail liability of its overheating.

The Advantages of a Large Main Reservoir.—In the 1896 Proceedings of the Air Brake Association an interesting test is recorded of the advantage gained by the use of a large main reservoir.

Four reservoirs were used, each with a capacity of 12,200 cubic inches, and so arranged that all could be used or some cut out, as desired. The test was made with a twenty-five car train.

Number of reservoirs cut in	Main reservoir pressure. Pounds.	Train-line pressure. Pounds.	Pressure at which both equalized.
4	100	0	50
2	100	0	35
4	100	50	72
4	90	50	67
2	100	50	68
2	100	50	63
2	90	50	61

The first column shows the number of reservoirs cut in. The second column the amount of main reservoir pressure before the release was made. The third column shows the amount of pressure in the train-line before release; while the fourth column shows the pressure at which both equalized when the brake handle was thrown into full release position. For example we will take the first two lines; reading from left to right. The first test was made with four main reservoirs cut in, 100 pounds pressure in them, and none in the train-line. In the last column is shown the pressure at which they equalized, which is 50 pounds. In the second line, representing the second test, only two main reservoirs were cut in; and the figures in the last column show they equalized at only 35 pounds, when the brake handle was thrown into full release position. This clearly illustrates the advantage of having a large main reservoir, besides obtaining a more prompt and certain release.

Location.—If possible the location of the Main Reservoir should always be such that the dirt, oil,

and moisture in the compressed air will drain into it; but location is a consideration subordinate to that of sufficient capacity. In order to secure sufficient capacity it is necessary in some cases to locate the Main Reservoir at the back of the tender; this practice is not advisable as it necessitates two additional lines of hose between the engine and tender, which form pockets in which water precipitated from the compressed air may collect, and in winter freeze, and where oil may accumulate and rapidly deteriorate the hose. The plan is also generally expensive. The best location for the Main Reservoir is back of the cylinder saddle, between the frames, or under the running boards; it is often found necessary to locate them under the cab footboards.

The use of two Main Reservoirs is very advantageous, in providing superior facilities for the condensation and precipitation of moisture and the deposit of oil and other foreign matter. The compressed air from the pump should be delivered into one and piped to the brake valve from the other, the two being connected by suitable piping.

The discharge pipe from the pump to the first main reservoir is usually made up of about 30 feet of pipe while the intermediate pipe should be about 25 feet in length. These lengths give the greatest cooling capacity without freezing. The points at which the air enters and leaves each reservoir should be as far separated as possible.

Main reservoirs should always be drained after each trip, the drain cock being left open during the

l between trips, in order to completely re-
il and water from the space provided for
air. A reservoir partly filled with water
espondingly reduced in capacity, which is
be accompanied by defective release and
charging of the brakes and by a hot pump;
water is likely to work back and accumu-
hose and sags in the train pipe, as well as in
le valves, where it may freeze and cause
trouble in winter.

lard Sizes and Capacities.—The following
sidered standard sizes of main air reser-
r locomotive use, as their shape will usually
ome one or two, and sometimes three, to
the necessary capacity. (Outside dimen-

Length inches.	Capacity cubic inches.
34	11,200
34	14,000
34	15,800
41	12,200
41	17,400
41	20,000
126	24,000
100	24,000

CHAPTER VII.

DUPLEX AIR GAUGE.

As was mentioned in the chapter "*Principal Parts,*" the duplex air gauge shows simultaneously the pressure in main reservoir and train-line; one hand (usually colored red) indicating main reservoir pressure while the other (colored black) shows train-line pressure. It is in reality two gauges combined in one, the same dial serving for both hands.

Operation and Principle of Action.—Two views of the air gauge are shown in plate G-9, Appendix. Figure 1 thereof is a standard gauge, Figure 2 is a semaphore gauge. An interior view, Figure 44, shows two bent tubes, A and B, elliptical in shape as shown at *d*. The tube B is connected to the fittings T, and the tube A to the fitting M. The bottom ends of the tubes are held fast, but the top ends are sealed, and free to move. The action is thus explained: if a tube of elliptical section is bent as shown at B, and then filled with an internal pressure (gas or liquid), the force will tend to straighten the tube. This is due to the fact that an inner force tends to make the tube round as in Figure *c*. In assuming the round form, the concave side *a*, see *d* of the bent tube tends to lengthen, while the convex

ide *b* tends to shorten. These combined efforts end to straighten the tube outward and impart movement to the free end. Tube A is connected to one end of lever *K j* by means of link *c*. his lever is pivoted at *e*, and the end *j* has the orm of a toothed sector, which meshes with a inion on the spindle *i*. The spindle *i* carries he red hand of the auge, and rotates ithin a hollow pindle *b*, which arries the black and. The tube B s connected by ink *b* to the lever *g* at a point below he fulcrum, or ivot, so that the lack hand will be urned in the same irection as the red ne. The lower end f *f g* has the form f a toothed sector which meshes with a pinion 1 the hollow spindle *l* and operates the black and.

DUPLEX AIR GAUGE

FIG. 44.

Since the main reservoir connects with M, air ider pressure enters tube A and tends to raighten it out. This causes the free end of A move to the left, drawing the link *c* with it, us moving the toothed sector *j* to the right. As s sector engages with the spindle *i*, the latter

is made to move clockwise, that is, a motion in the same direction as the hands of a clock. The red hand is also given a similar motion.

Train-pipe pressure acts within the tube B to straighten it, and the free end is moved to the right. As the bar *b* is connected below the fulcrum of the lever *f g*, the movement of the free end of B will cause the toothed sector *g* to move to the right, and turn the black hand clockwise also. The greater the pressure within the tubes, the greater will be the tendency for them to straighten out, and the higher will be the pressure registered by the gauge. The small coiled springs *d* and *h* take up the play, or backlash, in the teeth of the sector and pinion.

CHAPTER VIII.

TRAIN PIPE AND COUPLINGS.

(Plates G-1 and G-3, Appendix, show general arrangement.)

The *train pipe* consists of pipe running from end to end of the car or engine and is for the purpose of connecting each triple valve, and thus the brakes in each car, with the engineer's brake valve. Between the cars it is made continuous by flexible hose, attached to each car, with couplings for making the connections. Angle cocks for closing the separated connections are placed at each end of the pipe on each car; the branch pipe leading from the main train-pipe to the triple valve is a part of the train-pipe and located in it is a cut-out cock, so as to render any individual brake or triple valve inoperative without affecting the rest. A branch also leads to the conductor's valve, located in each passenger car, thus enabling the application of the brakes from any part of the train. The branch tee has a cylindrical strainer to prevent the particles of dust and dirt from entering the triple valves. The angle cock has a curved handle that stands parallel with pipe when open while the cut-out cock has a straight handle that stands crosswise with the cock when open. The "plugs" of these cocks are tapered and are held

in contact by springs pushing against the larger end (see Figure 6, plate G-34, Appendix). A small groove in the top of plug indicates that the cock is open if the groove is straight with the pipe; and closed if crosswise. A very clear view of the construction of the hose couplings is given in Figure 2, plate G-34. The joint between the connected hose couplings is made air-tight by a projecting rubber gasket 2. The couplings are so constructed that when pulled apart these rubber gaskets are forced together, permitting the couplings to separate with the least possible damage. The original intention of this construction was not that they should be separated in this manner, but to provide a means of them separating without tearing the hose or doing other damage in case the train broke in two. Even when the standard distance between their metal faces 3-32 of an inch exists, the resultant strain on the hose is quite severe when they contain air pressure. Careful tests demonstrated that with new gaskets and 70 pounds pressure in the train-line it required a strain of about 250 pounds pull to separate them. Thus it will be seen that under the most favorable conditions the hose is liable to be weakened or ruptured and the gaskets forced out of position; therefore the couplings should invariably be separated by hand.

CHAPTER IX.

CONDUCTOR'S VALVE.

(Plates G-1, G-32 and A-1, Appendix.)

The conductor's valve is simply a stop-cock placed in passenger, mail, baggage, express, and occasionally, caboose cars, with a cord attached to its handle, running the length of the car within easy reach of trainmen. The conductor's valve is connected to the train pipe by a branch-pipe and is for the purpose of letting a volume of air out of the train-pipe, thus applying the brakes quickly in case of emergency. When necessity requires its use, the conductor's valve should be pulled wide open and held so until the stop is completed.

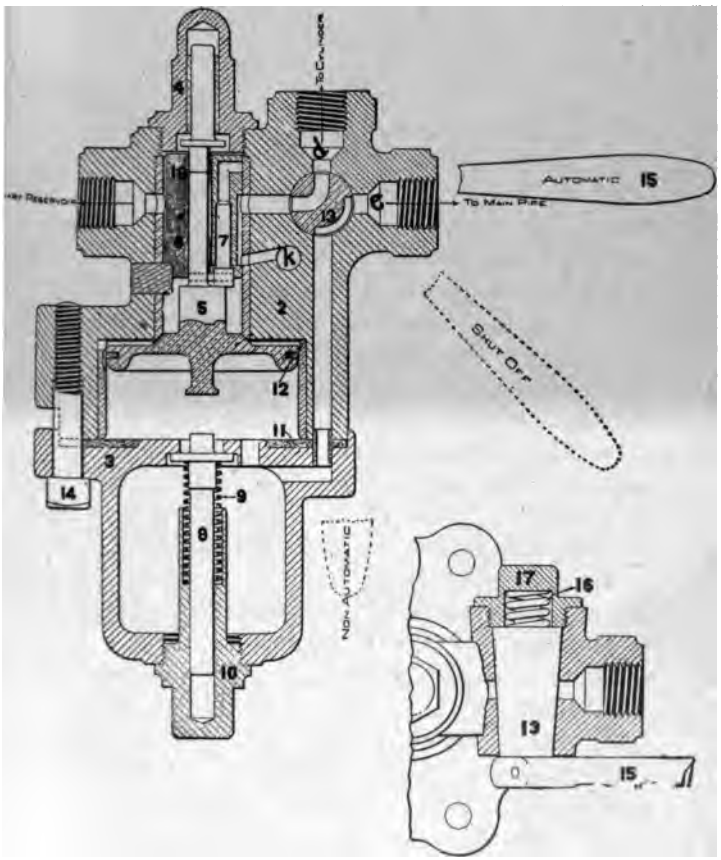
CHAPTER X.

THE TRIPLE VALVE.

As its name implies, the triple valve is a comb nation valve, performing three distinct duties (1) taking air from the train-line to charge th auxiliary; (2) when pressure is reduced from th train-line the feed to the auxiliary closes, an another part of the valve opens which allows th pressure stored in the auxiliary to pass into th brake cylinder, thus applying the brakes; and (3 when the pressure is again restored to the train line the triple opens communication from th brake cylinder, allowing the pressure there t escape to the atmosphere, thus releasing th brakes. There are two distinct kinds of trip valves in use. The first triple, which supplante the straight-air brake, is now known as the *plai triple valve,* to distinguish it from a later for which was called *the quick action triple valv* This later form is practically the same in princip of action and construction as the plain triple, wi the emergency or quick action parts added. T plain triple is still exclusively used on engines a tenders; when equipped with the high-speed bral the tender is supplied with a quick action trip Quick action triples are used on cars.

The Westinghouse Plain Triple Valve. (Fi

WESTINGHOUSE PLAIN TRIPLE
FIG. 45



ure 45.)—As the plain triple superseded th straight-air brake, it was necessary that it be s constructed that the automatic feature could b cut out and the brake converted into a "straight air" brake, as a great many cars were equipped with the latter form of brake. To accomplish this a three-way cock 13, through which the air passed from the train-line to the triple and from the triple to the brake cylinder, was placed in the body of the triple, and operated by the handle 15. The handle placed in the position shown rendered the triple operative for automatic brakes. If placed in a position pointing directly downward, it excluded all air from the parts of the triple, and permitted air from the train-line to flow directly into the brake cylinder, thus enabling that brake to be used as a "straight air brake." When the handle is placed in a position midway between these positions, it closes all the ports in the plug, thus cutting out the brake. When the straight-air became a thing of the past, a lug was cast on the handle to prevent it from being turned to the straight-air position. The later forms of plain triples have the plug cock removed and placed in the branch pipe leading to the triple.

There are three sizes of the plain triple at present in use: (1) the G-24, to be used with 8 and 1(inch brake cylinders; (2) the F-25 for use with 12 inch brake cylinders, and (3) the F-46 for us with 14 and 16 inch brake cylinders and for operating both the combined driver and truck brake fitted with the high speed brake. The difference

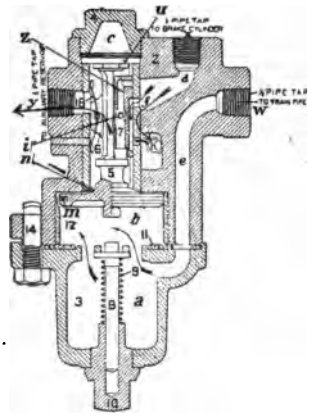
of the three consist only in the sizes of ports and parts; therefore a description of one will suffice for all.

Chamber A is made rather large so as to catch dirt and moisture which otherwise would get into the working parts of the triple and prevent its proper action; the dirt can be removed by screwing out the graduating stem nut 10. All air that reaches the triple must pass through chamber A. The leather gasket 11 fulfills two purposes: (1) it makes a joint between the cylinder cap 3 and the main body of the triple valve, and (2) it forms an air-tight seat for the piston 5 when the latter is at the bottom of its stroke, as shown in emergency position, Figure 49. The graduating stem 8 and spring 9 are used to prevent emergency position of the piston 5, during service application. Each figure shows a plain triple with all operative parts, thus giving a clearer idea of the appearance and construction of each part. It will be seen that graduating valve 7 bears on the shoulder of the piston 5, there is a small pin fastened into the stem of the piston and running through a hole in the head of the valve, thus causing the valve 7 to move with the piston 5; *m* is a small feed groove in the piston bushing; and *n* is a small groove in the shoulder of the triple piston, 5, and corresponds with the groove *m*; this allows air from the train-line to feed into the auxiliary reservoir when the triple piston 5 is in release position, as shown in Figure 46.

Port *i*, in the slide valve 6, is a hole clear

through the valve and is to allow the auxili pressure to reach the seat of the graduating v 7, which opens the passage Z, allowing the to flow into the brake cylinder when the brak applied. The branch pipe from the train- connects with the triple at W; the pipe lea

FIG. 46



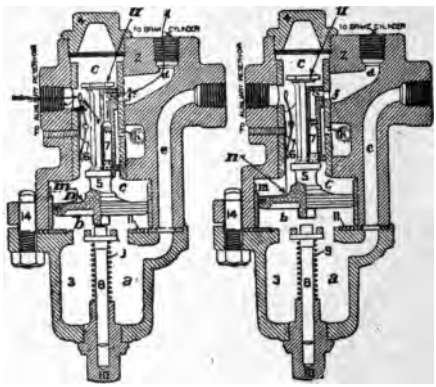
to the brake cylinde connected at X, while connection to the auxili reservoir is made at Chambers A and B c tain train-line pressu while chamber C is alw charged with auxili pressure.

Charging the Auxili —The position of triple shown in Figure is the position of the p for charging the auxili Air from the train-line enters at W, throug and fills the chamber A and B. This forces pis 5 to position shown and feeds air past the pis 5, through the groove *m* in the piston bus and the groove *n* in the piston, into chambe which is in direct communication with the au iary reservoir at Y. Thus auxiliary and tr line pressure eventually become equal, char at the rate of about one pound per second. feeding of air pressure from the train-line the auxiliary reservoir is the storage power the brake on that car.

Applying the Brakes. Service Application.— As has been already said, the train-line and auxiliary pressures become equal; a careful inspection will show that there is no way of air getting into the passage leading to the brake cylinder as long as the triple remains in this position. Now supposing the engineer desires to apply the brake. He moves the brake handle to service position, which reduces train-line pressure, and then "laps" the brake valve. The pressure in chamber C above piston 5 now being the greatest, forces the piston down. The instant piston 5 begins to move it closes the feed groove *m* and unseats the graduating valve 7 at W, and pressure from chamber C fills the passage Z, but cannot get into the passage *f, d,* leading to the brake cylinder. The slide-valve 6 is not fastened to the piston 5, but is drawn down by the collar *u* while coming in contact with it. By inspecting it in Figure 46 it will be seen there is a space between the collar and the valve, thus allowing the piston to move and unseat the graduating valve 7 without moving the slide-valve. But the piston 5 does not stop after unseating the graduating valve. When the collar *u* comes in contact with the slide-valve, the piston continues moving downward, drawing the slide-valve with it until the piston strikes the graduating stem 8. The passage Z of slide-valve is opposite passage *f, d,* leading to the brake cylinder, thus the pressure from the auxiliary reservoir feeds into the brake cylinder, applying the brake since the triple has now assumed the posi-

tion shown in Figure 47. This illustration shows the air still feeding from the auxiliary into the brake cylinder, as indicated by the arrows, which continues until the air in the auxiliary becomes reduced equal to or a trifle below the reduction made in the train-line, when the air below the piston 5, now being a trifle higher, forces the piston up sufficient to seat the graduating valve 7, at W (see Figure 48), and prevent any more air

FIG. 47 FIG. 48



SERVICE APPLICATION—LAP POSITION.

from the auxiliary entering the brake cylinder. As was said, the train-line pressure below piston 5 is now a trifle higher than the pressure above it, yet it is not sufficient to overcome the friction of the slide-valve 6 on its seat, therefore during such action the position of the slide-valve is not changed.

Should it be desired to apply the brake harder,

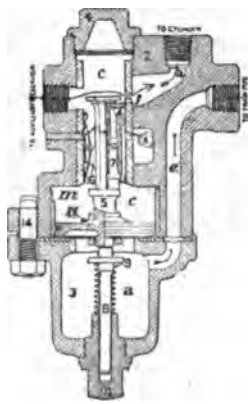
ıgineer lets a little more air out of the train-
which again reduces the pressure below pis-
, and it again moves down, carrying with
graduating valve 7, thus more air from the
ary flows into the brake cylinder until the
ary and train-line pressures again become
when it closes as before. The reduction of
·om the train-line need not necessarily be
by the engineer; a reduction of train-line
om any cause will apply the brakes. This
(1) be made by the engineer in the usual
with the brake valve; (2) by opening the
:ock on the end of the train; (3) by opening
luctıng valve; (4) by a hose or pipe burst-
ır (5) the train parting. When a service
tion of 20 pounds is made from the train-
he triple valve also causes the pressure in
ıxiliary to reduce 20 pounds, at which pres-
he auxiliary and brake cylinder become equal
ıe brake is fully applied, provided the piston
is about 8 inches. Any further reduction
:ssure from the train-line is a waste of train-
ir.

ergency Application.—To cause the emer-
application of the brakes it is necessary to
a sudden heavy reduction of the train-line
ıre. This sudden reduction causes auxiliary
ıre in chamber C to force piston 5 down
ıuickly, striking the graduating stem 8, com-
ng its spring and traveling the full length of
er B, to the position shown in Figure 49.
be seen this establishes a large and direct

communication, across the upper end of the slide-valve 6, equalizing the auxiliary and brake cylinder pressure. The emergency action of the plain triple causes it to set *more quickly,* but *not with greater force.*

Releasing the Brakes.—To release the brakes the engineer places the brake handle in full release position, which allows the air stored in the main reservoir to feed quickly into the train-line. Raising the pressure on the lower or train-line side of piston 5 (sufficient to overcome the auxiliary pressure and the friction of the slide-valve and piston), forces it upward to "release position," carrying the slide-valve with it. By an inspection of Figure 46 the cavity in the slide-valve 6 will be seen to connect the passage *d f* leading to port K, which opens to the atmosphere, thus allowing the pressure in the brake cylinder to escape, releasing the brake.

FIG. 49



EMERGENCY APPLICATION.

The triple has now assumed the position explained for "*charging the auxiliary,*" therefore the auxiliary reservoir is again recharged as explained under that head, through ports *m* and *n*.

The New York Plain Triple. (Plates Q-4 and Q-5, Appendix.)—The principle of action is so

nearly identical with the Westinghouse that the explanation for the latter will suffice.

The only material difference is the construction of the graduating valve, which is a small slide-valve 48, working directly on the cylinder seat, instead of inside the slide-valve. Also there is no emergency position for the New York plain triple, the valve assuming the same position in emergency as in service, thus there is no need for a graduating stem or spring.

Quick Action Triple. (Westinghouse.) — As has been said elsewhere, the quick action triple is simply a plain triple with quick action, or emergency parts added. Although the plain automatic triple satisfactorily fulfills all the requirements for ordinary service stops, it developed two serious faults in emergencies: (1) it required too long a time to get all the brakes fully applied, therefore valuable time was lost, as it took too great a distance in which to stop; (2) assuming the brakes were applied from the engine, the head brakes applied so much faster than the others as to cause a very serious shock to the rear portion of the train, doing damage to both draft rigging and freight. It was to overcome these two objections that the quick-action-triple was invented, and in addition to fulfilling these, it accomplishes another highly valuable feature when applied in emergency. Instead of all air in the train-line having to escape to the atmosphere through the brake valve, the quick action arrangement helps to take the train-line pressure out and

communication, across the upper end of the slide-valve 6, equalizing the auxiliary and brake cylinder pressure. The emergency action of the plain triple causes it to set *more quickly,* but *not with greater force.*

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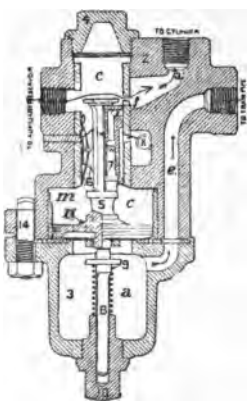
FIG. 49



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puts it into the brake cylinder; thus accompli
ing two purposes: (1) reducing the press
throughout the train-line quickly, and (2) incre
ing the brake cylinder pressure. The slide-va
3, of which a transparent view is shown in Fig
50, differs only from the plain triple slide-va
in having a new L-shaped port S in the end, a
a slot Q in one side near the same end; the
haust port *n* is also of a little different shape

WESTINGHOUSE QUICK-ACTION TRIPLE VALVE

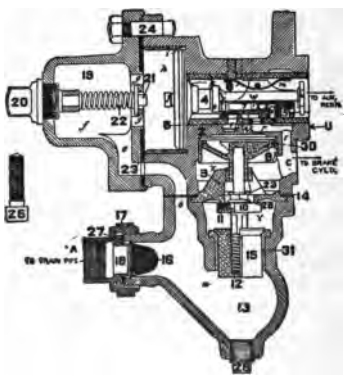
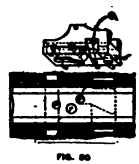


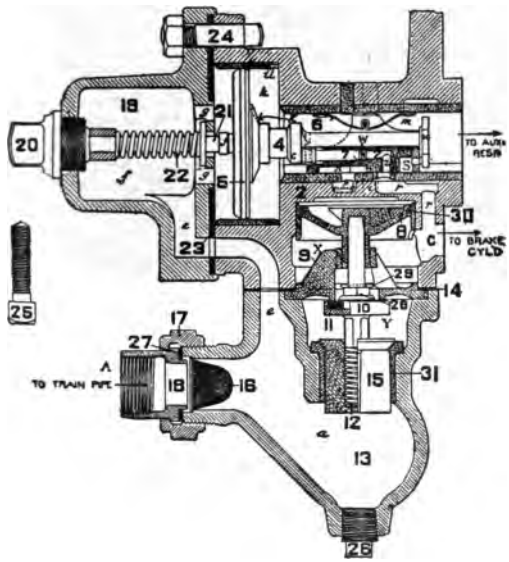
FIG. 51. RELEASE POSITION



order to connect another new port *t* in the s
with the exhaust port when in release and
charge, S is to let the auxiliary pressure into
brake cylinder in emergency application; t
when the plain triple makes a large opening
the air from the auxiliary to the brake cylir
the quick action valve makes a small one.
slotted port Q, in the side of the slide-valve i

open the port T, when the slide-valve has been drawn into emergency position by piston 5, admitting air pressure on top of the emergency valve piston 8, compressing it and causing the action of the emergency valves of the triple. Valves 10 and 15 form a sort of double check valve, as in their normal position air cannot pass both of them

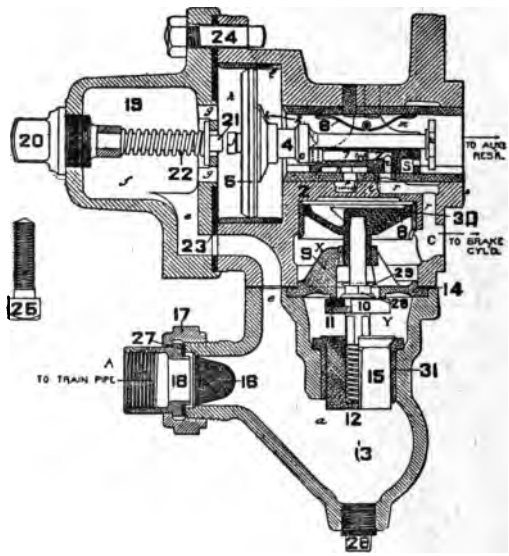
FIG. 52. SERVICE APPLICATION



in either direction. Train-pipe pressure, when first admitted into the triple at A, *a*, lifts the check valve 15 and fills chamber Y, but cannot get by the emergency valve 10. The same thing happens from the opposite direction, when, for instance, after an emergency application the pressure in

the brake cylinder above piston 10 may be forced from its seat, but brake cylinder pressure could not get any further than the chamber Y. The check valve spring 12, is to hold both valves to their seats when not acted on by air pressure. With the quick action triple all ordinary brake

FIG. 53. LAP POSITION



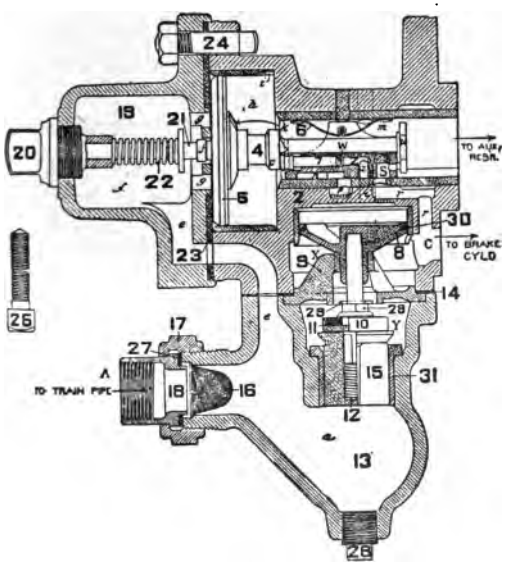
work is done entirely by the service or plain triple parts. The emergency part only being called into action by sudden heavy reductions.

The various positions of the working parts of this triple valve, in accomplishing its results, are illustrated in Figures 51, 52, 53 and 54.

Strainer 16 is designed to exclude foreign mat-

ter from the triple valve. Like the plain triple, piston 4 operates, in response to variations of train-pipe and auxiliary-reservoir pressures, to open and close feed groove *i*, and controls the movements of the slide-valve and the graduating valve. The latter is secured to the piston stem by a pin, shown in dotted lines.

FIG. 54. EMERGENCY APPLICATION



The graduating valve, moved by the main piston, controls the flow of air from the auxiliary-reservoir through service ports, ports *W* and *Z* of the slide-valve.

The slide-valve, moved by the main piston, con-

by it again forces the main piston to the left and unseats graduating valve 7, the slide-valve not moving. A corresponding further reduction of auxiliary-reservoir pressure results, through discharge of air into the brake cylinder. Such train-pipe reductions may be repeated until the auxiliary-reservoir and brake cylinder pressures have finally equalized; the brake is then fully applied, and any further train-pipe reduction is but a waste of train-pipe air. A total reduction of about 20 pounds causes the auxiliary-reservoir and brake cylinder pressures to equalize.

Emergency Application.—A gradual reduction of train-pipe pressure causes the main piston to move to the left until stem *j* encounters stem 21, when the tension of the graduating spring prevents further movement; but a sudden train-pipe reduction causes the main piston to move out so quickly that graduating spring 22 cannot withstand the impact of stem *j*, but yields so that the piston moves to the position shown in Figure 54. In this position of the parts, a diagonal slot in the slide-valve (shown in Figure 50) uncovers port *t* (indicated by the dotted lines just below the letter Z), which admits air from the slide-valve chamber to the chamber above emergency piston 8. Piston 8 is thereby forced downward and unseats emergency valve 10, allowing the pressure in the small chamber Y above check valve 15 to escape into the brake cylinder. Train-pipe pressure instantly raises the check valve and train-pipe air rushes through chamber *a*, Y and X into the brake cylin-

der at C. Air from the auxiliary-reservoir flows through port S of the slide-valve and passage *r* into the brake cylinder. Although the openings from the "train-line to the brake cylinder" and from the "auxiliary to the brake cylinder" are made practically at the same time, the latter opening is so much the smaller of the two, that as much of the train-line pressure as will flow in, has entered the brake cylinder before much of the pressure from the auxiliary can get in; therefore it is said "the pressure from the auxiliary flows into the brake cylinder in addition to the pressure already there from the train-line."

As soon as the pressure in the brake cylinder becomes equal to that in the train-line, the check valve 15 closes and prevents the brake cylinder pressure from flowing back into the train-line. When the auxiliary and brake cylinder pressures equalize the spring 12 closes the emergency valve 10 so that it will be on its seat when the brake is released. It thus occurs that, in an emergency application, 20 per cent increased brake cylinder pressure (total 60 pounds) is secured through the presence of the air supplied by the train-pipe in addition to that from the auxiliary-reservoir.

The rapid discharge of air from the train-pipe into the brake cylinder, in the manner just described, causes a sudden reduction of train-pipe pressure, which causes a similar operation of the triple valve upon the next car; the operation of that valve similarly affects the next, and so on, serially, throughout the train.

FIG. 55

N. Y. QUICK ACTION TRIPLE VALVE, RELEASE POSITION

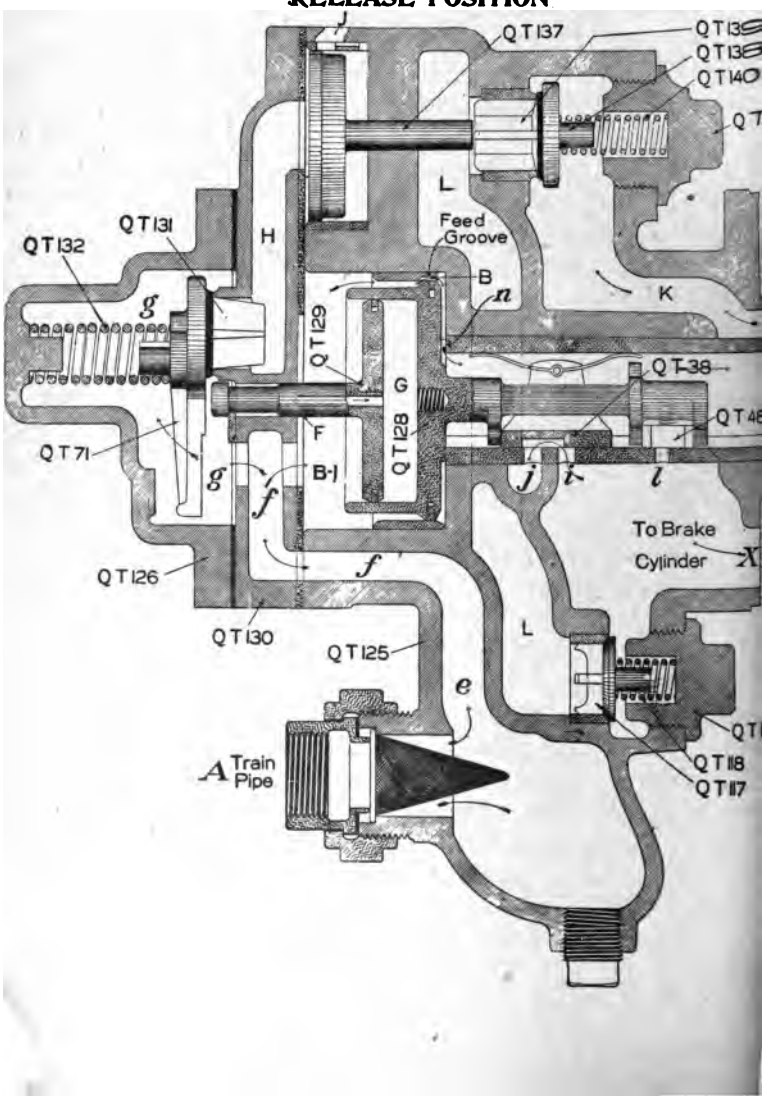


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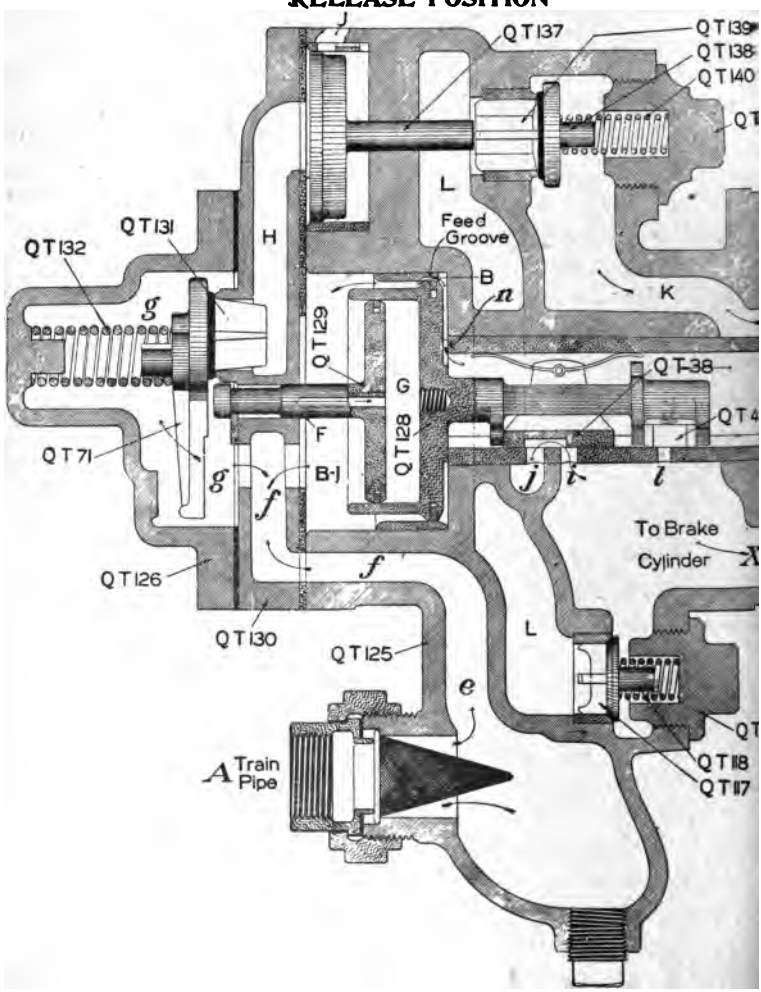
FIG. 55

N. Y. QUICK ACTION TRIPLE VALVE, RELEASE POSITION



Westinghouse becomes fully applied, it is set about 20 per cent. harder than the New York.

Like the Westinghouse, the New York quick action triple is simply a plain triple with a number of extra parts added, the extra parts constituting the emergency or quick action features. During all ordinary braking these parts lie dormant, and are only called upon in actual emergencies to apply the brakes quicker and with full force as soon as possible. The triple, as it actually appears, is shown in plate Q-6, Appendix, but on account of some of the mechanism, valves, etc., appearing at right angles, it makes it rather difficult to trace its action. Therefore conventional drawings of the triple in all positions are shown in accompanying Figures 55, 56, 57 and 58, and show more readily the relations of the different valves and passages. Referring to Figure 55, H is a passage formed around the valve body leading to emergency piston 137 and to the atmosphere through port J. This passage never contains any pressure except during the emergency action of the triple. K is a large passage from the auxiliary-reservoir to emergency valve 138, and always contains auxiliary-reservoir pressure. L.L. is a continuous passage leading from this emergency valve 138 to the brake cylinder check valve 117; and in emergency position provides a large passage for the air from the auxiliary to the brake cylinder in addition to the opening made by the graduating valve 48. F is a port drilled through the piston 129 for the purpose of charging

FIG. 57

N. Y. QUICK ACTION TRIPLE VALVE, LAP POSITION

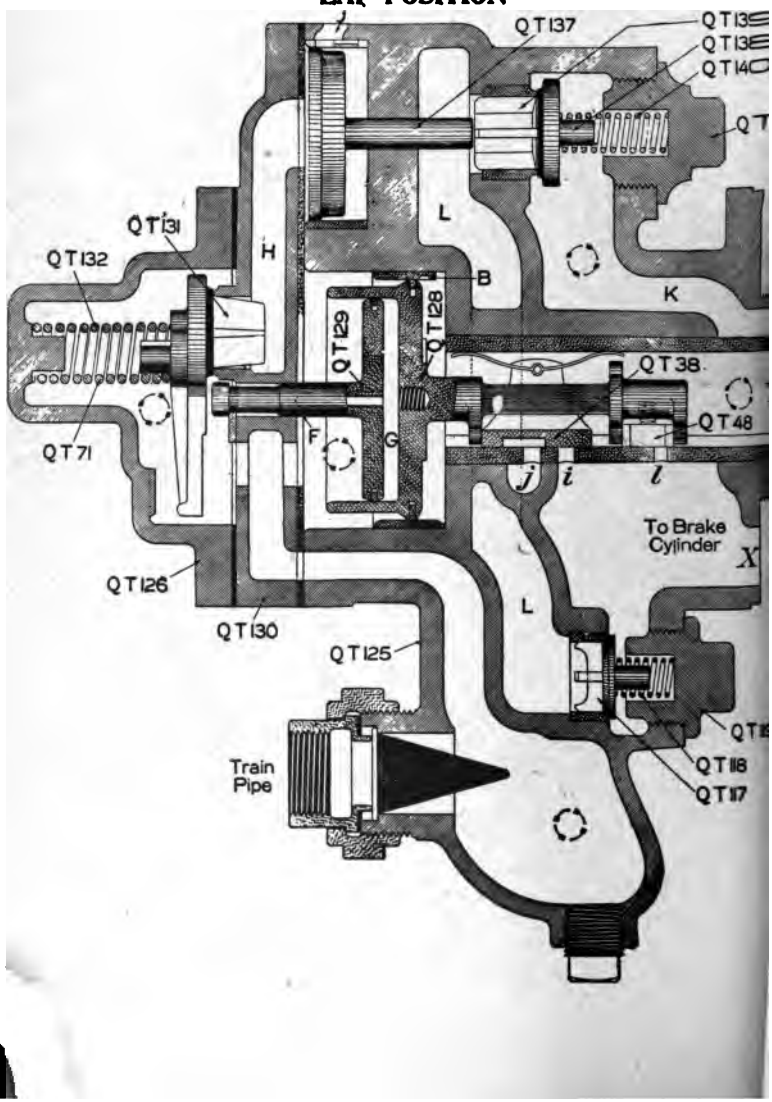
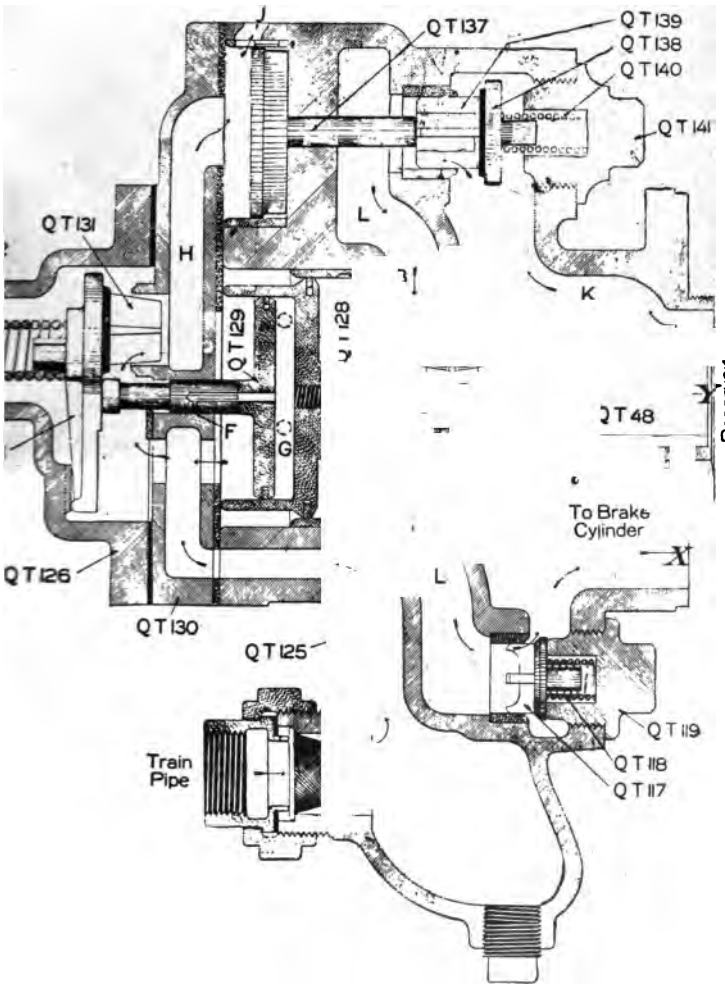


FIG. 58

N. Y. QUICK ACTION TRIPLE VALVE, EMERGENCY POSITION



chamber G between the two pistons 128 and 1

Charging.—Air from the train-pipe enter triple at A, Figure 55, flows through passag *f, f,* into chambers *g, g,* and B 1. Entering p air passes through the piston 129 into cha G, thus forcing piston 128 to the position sh Air from chamber B 1 flows through feed B and *n* into the auxiliary-reservoir at Y, as cated, thus charging the auxiliary equal t train-pipe pressure.

Service Application.—Though the action o quick action triple in service application is same as the plain triple, it will be observed, ever, in the former that the piston is constru so as to form a cylinder in which the vent-v piston 129 is fitted. When the train-line pres is reduced gradually the pressure in chamb reduces also, and allows the piston 128 to r to the left without moving the piston 129, as ing the position shown in Figure 56. This c feed groove B, moves the slide-valve 38 so it closes the exhaust port *i,* and graduating v 48 opens port *l,* allowing auxiliary air to flo the brake cylinder in quantities equal to that t from the train-pipe (or auxiliary air has equa with the brake cylinder). If a reduction pounds is taken from the train-pipe, thus lea 65 pounds against the train-pipe face of the p 128, the auxiliary air will flow into the brake inder till it becomes slightly less than 65 pou when the greater train-pipe pressure will the piston back sufficiently to close the gradu

valve 48, the slide-valve 38 not moving. This is "lap" position. Figure 57. If a further reduction is made from the train-pipe, which again leaves auxiliary pressure the greatest, the piston will again open the graduating valve 48, thus allowing more air to flow from the auxiliary to the brake cylinder. Like other triple valves, this one will respond to repeated reductions till the auxiliary and brake cylinder equalize.

Emergency or Quick Action Application.—It was said under the preceding head that when a reduction was made from the train-line pressure, chamber G pressure also reduced with it, flowing back through the small port hole F, which allowed the piston 128 to move toward piston 129 without disturbing it. This, however, only applies when a moderate reduction of train-line pressure is made. When it is desired to apply the brakes in emergency, a quick heavy reduction of the train-line pressure is made, and the air confined in chamber G, between the two pistons cannot escape as fast as the train-line pressure is reduced; so the piston 128 moving forward, cushions on the air in chamber G and drives piston 129 ahead of it. (See Figure 58.) The stem of piston 129 now strikes the vent valve 71 and forces it off its seat and air from the train-line rushes past it into passage H, compressing piston 137 and escaping to the atmosphere through port J; thus causing a quick reduction of the train-line pressure, that results in the emergency action of the next triple. When the train-line pressure rushes into chamber

chamber G between the two pistons 128 and 129.

Charging.—Air from the train-pipe enters the triple at A, Figure 55, flows through passages *e f, f,* into chambers *g, g,* and B 1. Entering port F air passes through the piston 129 into chamber G, thus forcing piston 128 to the position shown. Air from chamber B 1 flows through feed ports B and *n* into the auxiliary-reservoir at Y, as indicated, thus charging the auxiliary equal to the train-pipe pressure.

Service Application.—Though the action of the quick action triple in service application is the same as the plain triple, it will be observed, however, in the former that the piston is constructed so as to form a cylinder in which the vent-valve piston 129 is fitted. When the train-line pressure is reduced gradually the pressure in chamber G reduces also, and allows the piston 128 to move to the left without moving the piston 129, assuming the position shown in Figure 56. This closes feed groove B, moves the slide-valve 38 so that it closes the exhaust port *i,* and graduating valve 48 opens port *l,* allowing auxiliary air to flow to the brake cylinder in quantities equal to that taken from the train-pipe (or auxiliary air has equalized with the brake cylinder). If a reduction of 5 pounds is taken from the train-pipe, thus leaving 65 pounds against the train-pipe face of the piston 128, the auxiliary air will flow into the brake cylinder till it becomes slightly less than 65 pounds, when the greater train-pipe pressure will force the piston back sufficiently to close the graduating

valve 48, the slide-valve 38 not moving. This is "lap" position. Figure 57. If a further reduction is made from the train-pipe, which again leaves auxiliary pressure the greatest, the piston will again open the graduating valve 48, thus allowing more air to flow from the auxiliary to the brake cylinder. Like other triple valves, this one will respond to repeated reductions till the auxiliary and brake cylinder equalize.

Emergency or Quick Action Application.—It was said under the preceding head that when a reduction was made from the train-line pressure, chamber G pressure also reduced with it, flowing back through the small port hole F, which allowed the piston 128 to move toward piston 129 without disturbing it. This, however, only applies when a moderate reduction of train-line pressure is made. When it is desired to apply the brakes in emergency, a quick heavy reduction of the train-line pressure is made, and the air confined in chamber G, between the two pistons cannot escape as fast as the train-line pressure is reduced; so the piston 128 moving forward, cushions on the air in chamber G and drives piston 129 ahead of it. (See Figure 58.) The stem of piston 129 now strikes the vent valve 71 and forces it off its seat and air from the train-line rushes past it into passage H, compressing piston 137 and escaping to the atmosphere through port J; thus causing a quick reduction of the train-line pressure, that results in the emergency action of the next triple. When the train-line pressure rushes into chamber

H and compresses the piston 137, the stem of piston 137 strikes the emergency valve 138, driving it off its seat, and air from the auxiliary-reservoir suddenly flows to the brake cylinder through the passage L, L, and past the check valve 117. Auxiliary air also flows to the brake cylinder past the graduating valve 48 and through the service port *l*. This figure shows the triple in emergency action, the course of the air being shown by the arrows. It is to be understood that to get quick action with this valve, the result must be sought before any service application is made. If the triple is moved to service position with the least service reduction all of chamber G air will flow back into the train-pipe, as shown in Figure 56, or the volume will be greatly reduced on "lap" as in Figure 57. The triple must be in release position with chamber G, fully charged, to later effect the emergency action. After emergency action the check valve 117 reseats to prevent the brake cylinder pressure from passing back into chamber L; vent valve 71 and piston 129 are moved back to their normal positions by spring 132 after chamber G has reduced through port F sufficiently to permit it. After vent valve 71 closes, train-pipe air ceases to act on piston 137, and spring 140 reseats valve 139.

Release.—After service or emergency application, the triple releases the brake as by other triple valves recently mentioned, air from the train-pipe again enters at A and finds its way to the triple piston. charging chamber G through

port F, until it is strong enough to overcome the auxiliary pressure. The piston is moved to the right as in Figure 55, the slide-valve cavity allowing the brake cylinder air to escape through ports *i* and *j* to the atmosphere, while the feed groove B of the cylinder allows the auxiliary to recharge.

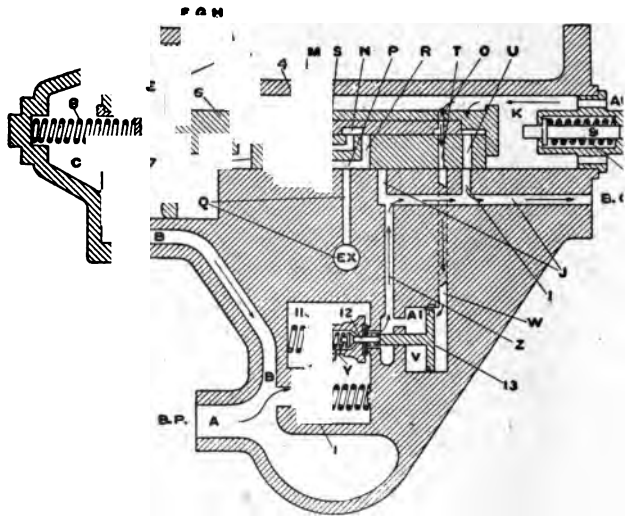
NOTE:—Descriptions of and instructions for manipulation of Modern Westinghouse Triple Valves will be found in the Appendix hereto.

The New York K-6 Triple Valve for Freight Service.—The triple valve illustrated and described on the following pages is designed to meet the demand of such railroads as may desire a freight car triple valve which provides for a quick serial service application of the brakes in a service reduction, a restricted release of the forward brakes, and a more uniform recharge of auxiliary reservoirs.

This triple valve performs all the functions of the older type of quick action triple valve, as well as three additional functions, viz.: Quick Service, Restricted Release and Uniform Recharge. It can be used in the same train with the older type of triples, and it improves the action of the latter when so used. It is well adapted for use on long or short trains.

The triple, as it actually appears, is shown in Plate Q2B, Appendix.

The Quick Service function results in quick serial operation of the brakes, by venting brake pipe air to the brake cylinder in service application, on the same principle and by substantially

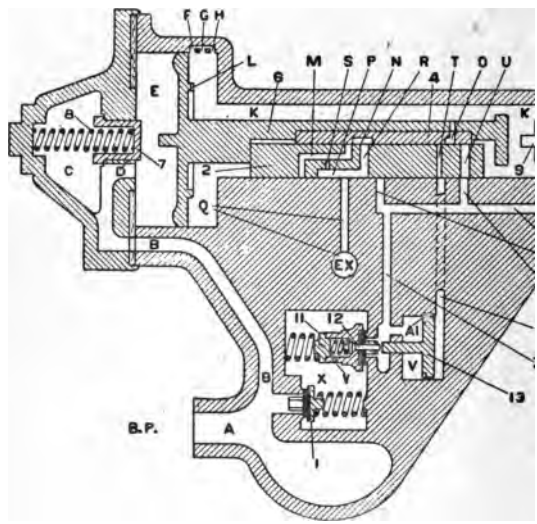


SERVICE POSITION.
FIG. 58B.

Normal Release and Recharging Position.—Air from the brake pipe enters the triple valve at A, passes through passage B to chamber C, through passage D to chamber E, through feed ports F, G and H to chamber K and auxiliary reservoir. The rate of charging the auxiliary reservoir in this position is approximately the same as with the older type of triple valve (H-1) on the same size reservoir. While the piston 6 and slide valve 2 are in this position, cavity P in slide valve 2 connects brake cylinder passage J and exhaust passage Q, giving a normal exhaust to the atmosphere. See Fig. 58A.

When piston 6 is in the position shown in Fig. 58A, port F is partly closed so as to reduce to a minimum the back flow from the auxiliary to the brake pipe, however, when the brake pipe pressure at any time is slightly above the pressure in the auxiliary reservoir, piston 6 will be moved by the brake pipe pressure to the right against the power of spring 10, fully uncovering port F. Air from the brake pipe can then feed more rapidly to the auxiliary reservoir by means of the port F and the combined capacity of ports G and H.

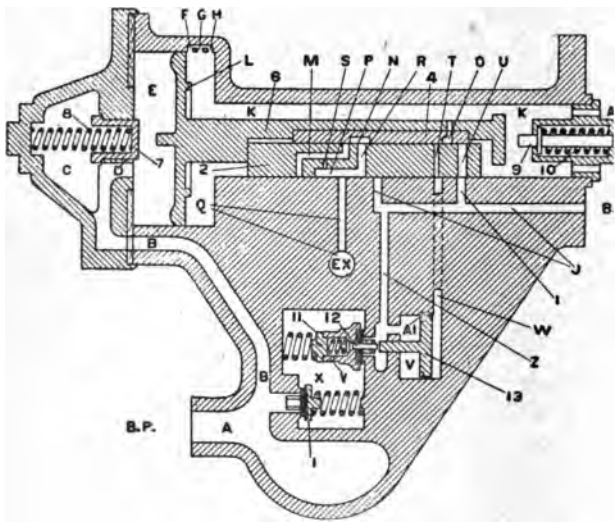
As soon as the pressure becomes practically equalized, the power of spring 10 will again return piston 6 to the position shown in Fig. 58A and the air will flow from the brake pipe to the auxiliary reservoir until the brake pipe and auxiliary reservoir pressures become equal. At the same time that auxiliary is being charged the



SERVICE LAP POSITION.
FIG. 58C.

brake pipe pressure will unseat check valve 1, and chamber X will be charged equal to brake pipe pressure.

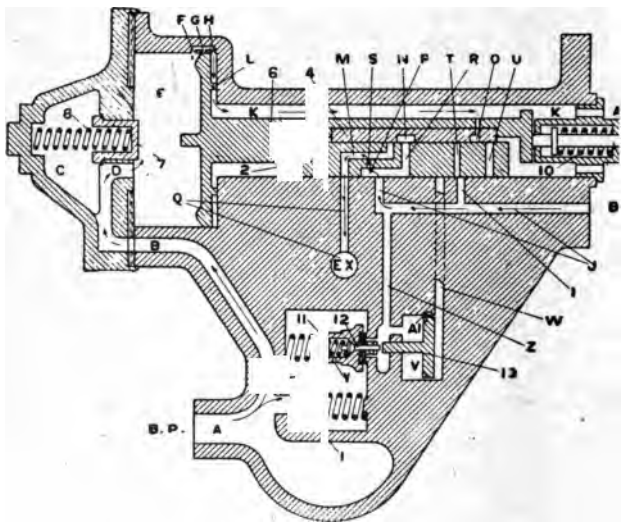
Service Position.—When it is desired to make a service application of the brakes, a gradual reduction of brake pipe pressure is made with the brake valve and this reduction in the brake pipe and chamber E causes piston 6 to be moved to the left by the preponderance of pressure in the auxiliary reservoir, or chamber K, until the stem of piston 6 comes in contact with graduating stem 7, which is held in place by the tension of graduating spring 8. This movement of piston 6 carries graduating valve 4 and slide valve 2 to the position shown in Fig. 58B. When slide valve 2 and graduating valve 4 have assumed the position shown in Fig. 58B, passage J is cut off from passage Q leading to the exhaust port and air from the auxiliary reservoir passes through port U in slide valve 2 and port J to the brake cylinder, at the same time auxiliary air feeds through port O in the graduating valve 4 and port T in slide valve 2, and passage W leading to the emergency piston. The pressure will now build up on the emergency piston sufficient to unseat inner check valve 12, which will reduce the pressure in chamber X. The brake pipe pressure will then unseat valve 1 and brake pipe air will flow past this valve through small port Y, past the inner check valve 12 into chamber V, through passage Z and passage J to the brake cylinder.



SERVICE LAP POSITION.
FIG. 58C.

brake pipe pressure will unseat check valve 1, and chamber X will be charged equal to brake pipe pressure.

Service Position.—When it is desired to make a service application of the brakes, a gradual reduction of brake pipe pressure is made with the brake valve and this reduction in the brake pipe and chamber E causes piston 6 to be moved to the left by the preponderance of pressure in the auxiliary reservoir, or chamber K, until the stem of piston 6 comes in contact with graduating stem 7, which is held in place by the tension of graduating spring 8. This movement of piston 6 carries graduating valve 4 and slide valve 2 to the position shown in Fig. 58B. When slide valve 2 and graduating valve 4 have assumed the position shown in Fig. 58B, passage J is cut off from passage Q leading to the exhaust port and air from the auxiliary reservoir passes through port U in slide valve 2 and port J to the brake cylinder, at the same time auxiliary air feeds through port O in the graduating valve 4 and port T in slide valve 2, and passage W leading to the emergency piston. The pressure will now build up on the emergency piston sufficient to unseat inner check valve 12, which will reduce the pressure in chamber X. The brake pipe pressure will then unseat valve 1 and brake pipe air will flow past this valve through small port Y, past the inner check valve 12 into chamber V, through passage Z and passage J to the brake cylinder.



RESTRICTED RELEASE POSITION.
FIG. 58D.

In this position of the emergency piston 13 by-pass port A-1 is open to the right of the piston allowing the auxiliary reservoir pressure which has built up, on the right of the emergency piston to equalize with the brake cylinder pressure on the left of the piston, in chamber V. Any pressure that might accumulate at the right of piston 13 in excess of that sufficient to unseat inner check valve 12 will be relieved by by-pass port A-1. By this means a serial venting is obtained from the brake pipe to the brake cylinder in service application.

Service Lap Position.—When the desired brake pipe reduction has been made and the brake valve exhaust has closed, as the relative capacity of ports U and O are such that the auxiliary reservoir pressure will be reduced at a more rapid rate than the brake pipe will reduce through port Y, the greater pressure in chamber E will cause piston 6 and graduating valve 4 to move to the right and assume the position shown in Fig. 58C, which is known as service lap position.

When the brake pipe reduction ceases and the auxiliary reservoir pressure by flowing through ports U, I and J to the brake cylinder becomes slightly less than the brake pipe pressure, piston 6 and graduating valve 4 are moved to the right until the shoulder of piston 6 comes in contact with the end of slide valve 2. This movement closes ports U and T, thus preventing any fur-

chamber G between the two pistons 128 and 129.

Charging.—Air from the train-pipe enters the triple at A, Figure 55, flows through passages *e, f, f,* into chambers *g, g,* and B 1. Entering port F air passes through the piston 129 into chamber G, thus forcing piston 128 to the position shown. Air from chamber B 1 flows through feed ports B and *n* into the auxiliary-reservoir at Y, as indicated, thus charging the auxiliary equal to the train-pipe pressure.

Service Application.—Though the action of the quick action triple in service application is the same as the plain triple, it will be observed, however, in the former that the piston is constructed so as to form a cylinder in which the vent-valve piston 129 is fitted. When the train-line pressure is reduced gradually the pressure in chamber G reduces also, and allows the piston 128 to move to the left without moving the piston 129, assuming the position shown in Figure 56. This closes feed groove B, moves the slide-valve 38 so that it closes the exhaust port *i,* and graduating valve 48 opens port *l,* allowing auxiliary air to flow to the brake cylinder in quantities equal to that taken from the train-pipe (or auxiliary air has equalized with the brake cylinder). If a reduction of 5 pounds is taken from the train-pipe, thus leaving 65 pounds against the train-pipe face of the piston 128, the auxiliary air will flow into the brake cylinder till it becomes slightly less than 65 pounds, when the greater train-pipe pressure will force the piston back sufficiently to close the graduating

ther flow of air from the auxiliary reservoir to the brake cylinder.

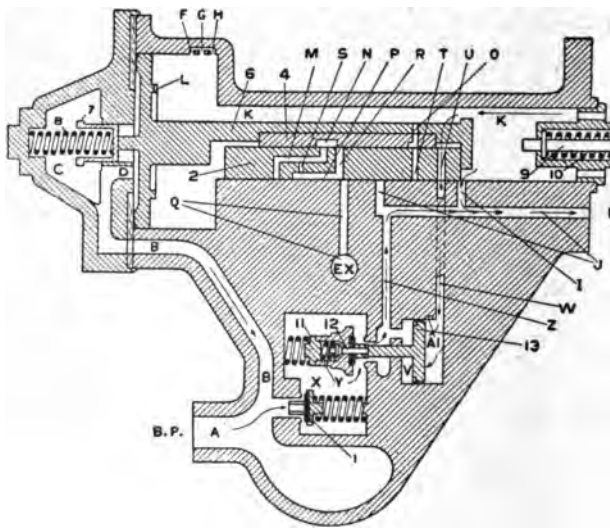
If it is desired to make a heavier application, a further reduction of brake pipe pressure is made and piston 6 will be moved again to the left carrying with it graduating valve 4, uncovering feed port U, permitting additional air from the auxiliary to feed to the brake cylinder. As soon as the auxiliary pressure is again reduced below that of the brake pipe, piston 6 will be returned to the right, carrying with it graduating valve 4 and closing port U.

This operation can be repeated until the auxiliary reservoir and brake cylinder pressures become equal.

Restricted Release Position.—When it is desired to put the triple valves in restricted release position, air is admitted to the brake pipe in sufficient volume to force piston 6, slide valve 2 and graduating valve 4 to the position shown in Fig. 58D.

In this position the upper end of port M is closed by graduating valve 4 and air from the brake cylinder will pass through passage J into cavity P, up through small port S into passage M to exhaust port Q, thus restricting the release of air from the brake cylinder. The flow of air from the brake cylinder to the atmosphere is limited to the capacity of small port S.

When piston 6 is held in the position shown in Fig. 58D, the triple piston packing ring covers

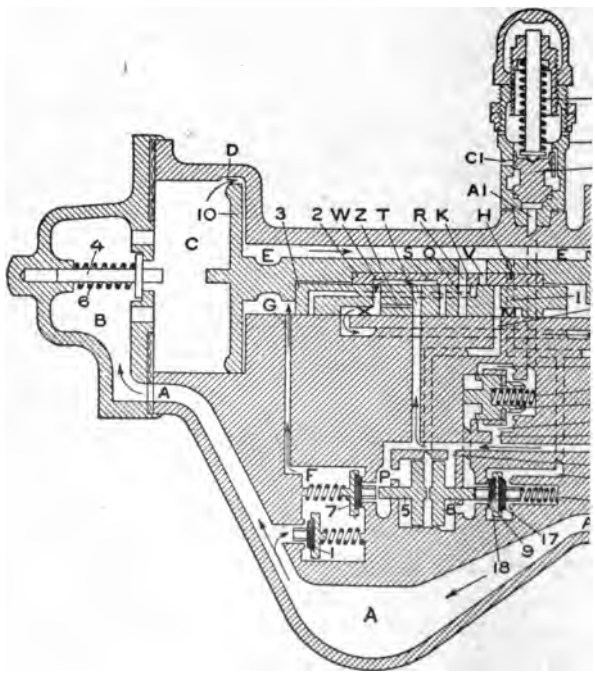


EMERGENCY POSITION.
FIG. 58F.

port G, limiting recharging of the auxiliary to the capacity of port H in the triple cylinder bushing.

Normal Release After Restricted Release.—When piston 6 moves to the position shown in Figure 58D, it moves stem 9 to the right, compressing spring 10 and when the auxiliary reservoir pressure becomes nearly equal to the brake pipe pressure, spring 10 forces stem 9, piston 6 and graduating valve 4 to the left to the position shown in Fig. 58E. In this position cavity N in the graduating valve connects brake cylinder passage J with passage R, and uncovers the upper end of port M, thus connecting to the exhaust port Q, giving a free exhaust from the brake cylinder to the atmosphere.

Emergency Position.—When an emergency application of the brakes is desired, a quick reduction of the brake pipe pressure is made, causing piston 6, slide valve 2 and graduating valve 4 to move to the position shown in Fig. 58F. In this position piston 6 seats on the leather gasket, forming an air tight joint and prevents leakage of air from the auxiliary reservoir to the brake pipe. With slide valve 2 and graduating valve 4 in the position shown, port U registers with passage W, permitting air from the auxiliary reservoir to flow to emergency piston 13, forcing piston to the extreme left, unseating quick action valve 11, permitting brake pipe air to flow past check valve 1 and quick action valve 11, through passages Z and J to the brake cylinder.



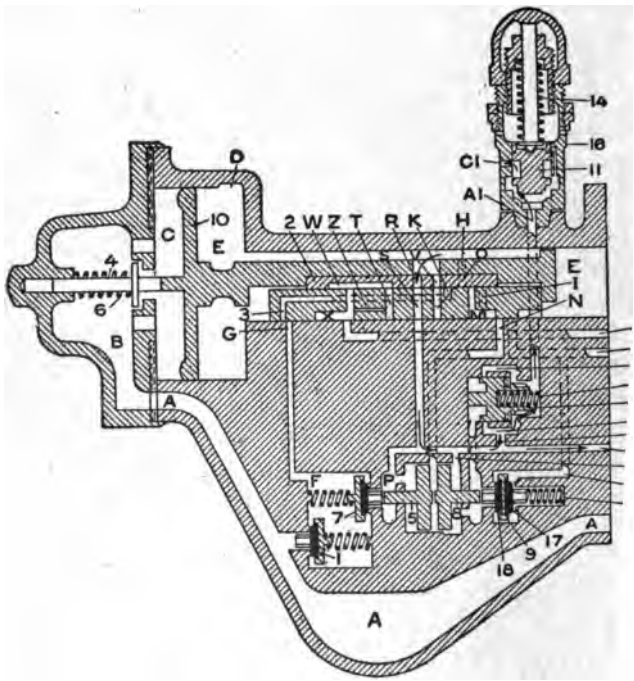
FULL RELEASE AND CHARGING POSITION.
FIG. 58G.

Due to the large opening through ports U and W, auxiliary reservoir pressure is admitted to the right of piston 13 in such quantity as to force the piston beyond by-pass port A-1, thus preventing the power on the right of the piston being destroyed before emergency is completed. At the same time air from the auxiliary reservoir passes through ports I and J to the brake cylinder, causing a quick and full application of the brakes.

When the brake pipe and brake cylinder have become nearly equalized, check valve 1 will be returned to its seat by the spring QT-118-A, preventing any back leakage from the brake cylinder to the brake pipe. The release of the brakes following an emergency application is brought about in the same way as following a service application.

The New York Type J. Triple Valve is intended for use on all classes of passenger trains. This valve is made in two styles, Style "A" and Style "B," and both are Quick Action, Automatic and of the Pipeless type. Suitable pipe connections are provided for in the Type J Triple Valve, whether it is connected to a bracket, or direct to the brake cylinder.

Style "A" is fitted with a High Emergency-Pressure Cap, and 32 R. V. Safety Valve in connection with a supplementary reservoir, and is so constructed as to guard against sliding of wheels when making the slow-speed or ordinary station stops, but retains the maximum pressure throughout in emergency applications, when it is neces-



FULL SERVICE POSITION.
FIG. 58H.

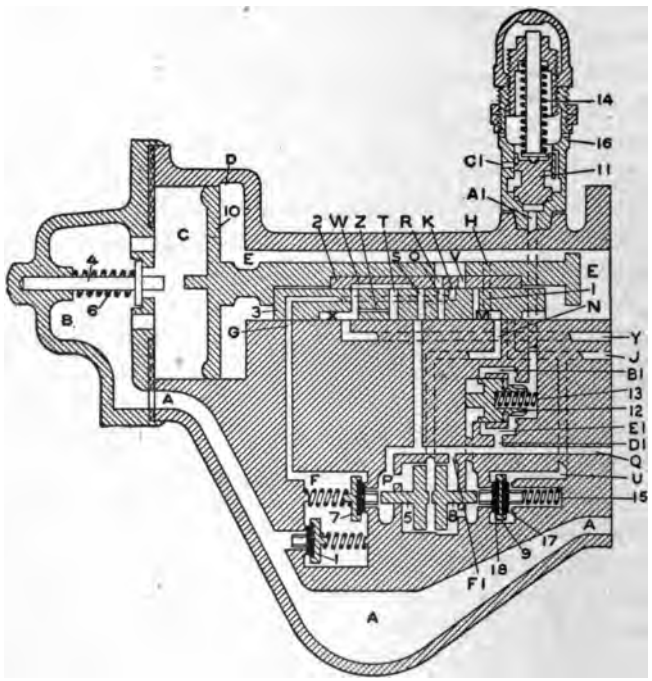
sary to stop in the shortest possible distance. Style "B" performs the same functions as Style "A," except those in connection with the High Emergency Pressure Cap, Safety Valve and supplementary reservoir, therefore Style "A" is described.

The principal features of the Type J Triple Valves are as follows:

Quick Recharge of Auxiliary Reservoirs:—The auxiliary reservoirs are recharged in about the same time required to release the air from the brake cylinders, therefore, the maximum braking pressure is available at all times.

High Emergency Cylinder Pressure.—This pressure, which is much higher than the maximum in service applications, is obtained by the use of the High Emergency Pressure Cap, and the Supplementary Reservoir, and is retained throughout the stop.

Full Release and Charging Position.—Fig. 58G shows the valve in Full Release and Charging Position. Air from the brake pipe enters at A, passes to chambers B and C, then through feed groove D, to chamber E, and the auxiliary reservoir. Air from passage A also unseats check valve 1, and passes through chamber F and port G to chamber E, and the auxiliary reservoir. In this position, auxiliary reservoir pressure flows through port H in graduating valve 2, port I in slide valve 3, and port J in the seat to the supplementary reservoir, and brake cylinder pres-

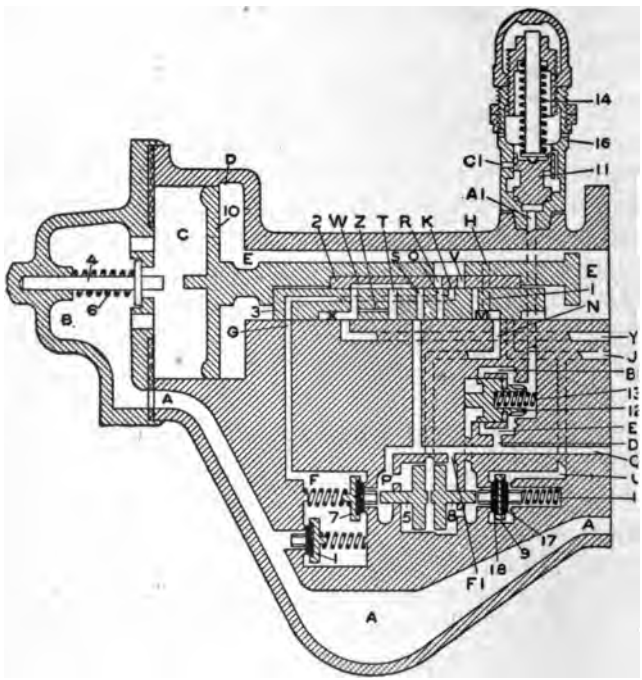


LIGHT SERVICE LAP POSITION.
FIG. 581.

sure flows through port Q in the seat, ports T and Z in slide valve 3, cavity W in graduating valve 2, port X in slide valve 3, and port Y in the seat to the atmosphere, thus recharging the auxiliary and supplementary reservoirs, and releasing the brakes.

Service Application Position.—Fig. 58H shows the valve in the Service Position. A slight reduction of the brake pipe pressure at the brake valve, reduces the pressure in chamber C, and piston 10 is moved to the left by the greater pressure, which is then contained in chamber E, and the auxiliary reservoir, carrying graduating valve 2, and slide valve 3 to the position shown in Fig. 58H. Auxiliary Reservoir pressure now flows through ports R, S and Q to the brake cylinder. The service ports are so proportioned as to insure against obtaining an Emergency Application of the brakes when making a Service Application. In Service Applications, the Safety Valve, which is set to close at 60 pounds, is in communication with the brake cylinder through ports A1, E1, D1 and Q, and the brake cylinder pressure is kept within the adjustment of the Safety Valve to prevent danger of sliding wheels.

Lap Position.—When a light reduction of brake pipe pressure is made and the auxiliary reservoir pressure becomes slightly less than the brake pipe pressure in chamber C, the brake pipe pressure moves piston 10 and graduating valve 2 to Lap Position, as shown in Fig. 58I, closing all

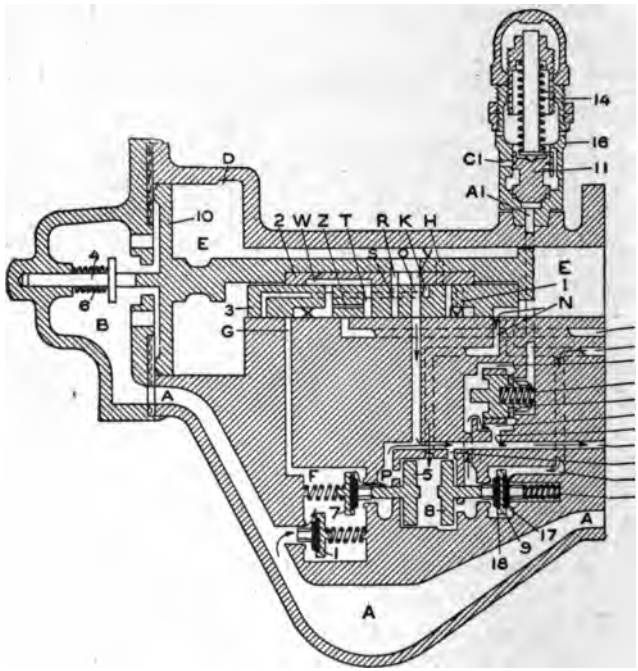


LIGHT SERVICE LAP POSITION.
FIG. 581.

sure flows through port Q in the seat, ports T and Z in slide valve 3, cavity W in graduating valve 2, port X in slide valve 3, and port Y in the seat to the atmosphere, thus recharging the auxiliary and supplementary reservoirs, and releasing the brakes.

Service Application Position.—Fig. 58H shows the valve in the Service Position. A slight reduction of the brake pipe pressure at the brake valve, reduces the pressure in chamber C, and piston 10 is moved to the left by the greater pressure, which is then contained in chamber E, and the auxiliary reservoir, carrying graduating valve 2, and slide valve 3 to the position shown in Fig. 58H. Auxiliary Reservoir pressure now flows through ports R, S and Q to the brake cylinder. The service ports are so proportioned as to insure against obtaining an Emergency Application of the brakes when making a Service Application. In Service Applications, the Safety Valve, which is set to close at 60 pounds, is in communication with the brake cylinder through ports A1, E1, D1 and Q, and the brake cylinder pressure is kept within the adjustment of the Safety Valve to prevent danger of sliding wheels.

Lap Position.—When a light reduction of brake pipe pressure is made and the auxiliary reservoir pressure becomes slightly less than the brake pipe pressure in chamber C, the brake pipe pressure moves piston 10 and graduating valve 2 to Lap Position, as shown in Fig. 58I, closing all



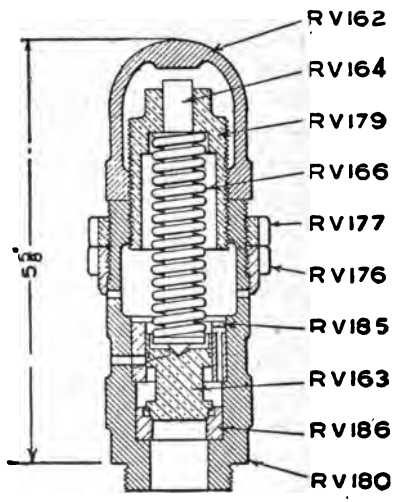
EMERGENCY POSITION.
FIG. 58J.

ports, and stopping the flow of auxiliary reservoir pressure to the brake cylinder. A slight brake pipe reduction will again move the valve to the Service Position, after which it will again move to Light Service Lap or Full Service Lap, according to its previous position, both of which are identical, except that in Full Service Lap, slide valve 3 would occupy the position shown in Figure 58H, while in Light Service Lap, it would still occupy the position shown in Fig. 58I. This operation can be repeated until the auxiliary reservoir and brake cylinder pressure become equalized.

Release and Recharge.—When the brake pipe pressure is restored, after Service Application, or when the valve is in Lap Position, the piston, slide valve and graduating valve are returned to the position shown in Figure 58G, and the brakes released and auxiliary reservoirs recharged as described under Full Release and Charging Position.

Emergency Position.—Fig. 58J shows the valve in Emergency Position. This position is caused by putting the brake valve handle in the Emergency Position, or from the Conductor's Valve, or any condition that suddenly reduces the brake pipe pressure. Auxiliary reservoir pressure flows through port N, moving pistons 5 and 8 to the left and right respectively, unseating quick action valve 7, and emergency valve 9, causing check valve 1 to be unseated by brake pipe pres-

sure, which then flows to port Q, and the b
cylinder, while at the same time supplemen
reservoir pressure flows from port J ar
emergency valve 9 to chamber around the
of valve 12, moving this valve to its seat and



SAFETY VALVE.
FIG. 58K.

LISTS OF PARTS

RV 162, Cap Nut,
RV 163, Valve,
RV 164, Valve Stem,
RV 166, Spring,
RV 176, Exhaust Regulating
RV 177, Lock Ring,
RV 179, Regulating Nut,
RV 180, Body (bushed).

ing communication to port A1, and the Sa
Valve, then flowing through passage D1, to
Q and the brake cylinder, thus obtaining the
imum brake cylinder pressure and holding
throughout the stop, or until released in the

ular way. During the application, and when the brake pipe and brake cylinder pressures become equal, check valve 1 will be returned to its seat, by the spring, preventing brake cylinder pressure from flowing back into the brake pipe. When the brakes are released after an emergency application, spring 13 will move valve 12 to its normal position, as shown in Figure 58G.

Safety Valve, Fig. 58K.—In Service Applications as shown in Fig. 58H, brake cylinder pressure is in direct communication with the Safety Valve, through port Q, passages D1, E1 and port A1. When the pressure rises above the adjustment of the Safety Valve, valve 11 is raised against the resistance of spring 14 and the excess of pressure flows through port C1 to the atmosphere. In Emergency Applications, as shown in Fig. 58J, brake cylinder pressure is cut off from the Safety Valve by valve 12, as fully explained under *"Emergency Position."*

Installation and Maintenance.—This triple valve should be given the same care as is recommended for all triple valves in heavy passenger train service. It should be cleaned and oiled by a competent man once in three months, and should be removed from the car and taken to the repair shop for this purpose.

When used in connection with Style "A," a cut-out cock should be placed between the supplementary reservoir and the cylinder head, and the old and new valves will then work in harmony.

CHAPTER XI.

AUXILIARY RESERVOIR AND BRAKE CYLINDER.

The Auxiliary Reservoir (Westinghouse and New York) is for the purpose of storing a supply of compressed air on each engine, tender and car in the train, from which the triple valve draws its air to put into the brake cylinder to apply the brake on the car or engine on which it is placed. The pressure in an auxiliary-reservoir when fully charged, is equal to train-line pressure. The release valve, which is more commonly called the "bleed cock," is for the purpose of reducing or "bleeding" the auxiliary pressure when a brake "sticks" on any particular car or for releasing a brake when the engine is cut off. By opening this valve the auxiliary pressure is reduced below that in the train-line, consequently train-line pressure forces the triple piston to release position and releases the brake. This valve should only be held open until the air is heard to release at the triple exhaust. The bleed cock is generally placed in the bottom of the passenger auxiliaries and serves also for a drain cock.

In the freight auxiliaries they are mostly at the top, in such case a drain plug is screwed into the bottom.

The Brake Cylinder is where the actual

work of the air begins and ends. It is the pressure finally exerted and retained a requisite time in the brake cylinder which determines the efficiency of

PASSENGER AUXILIARY AND CYLINDER

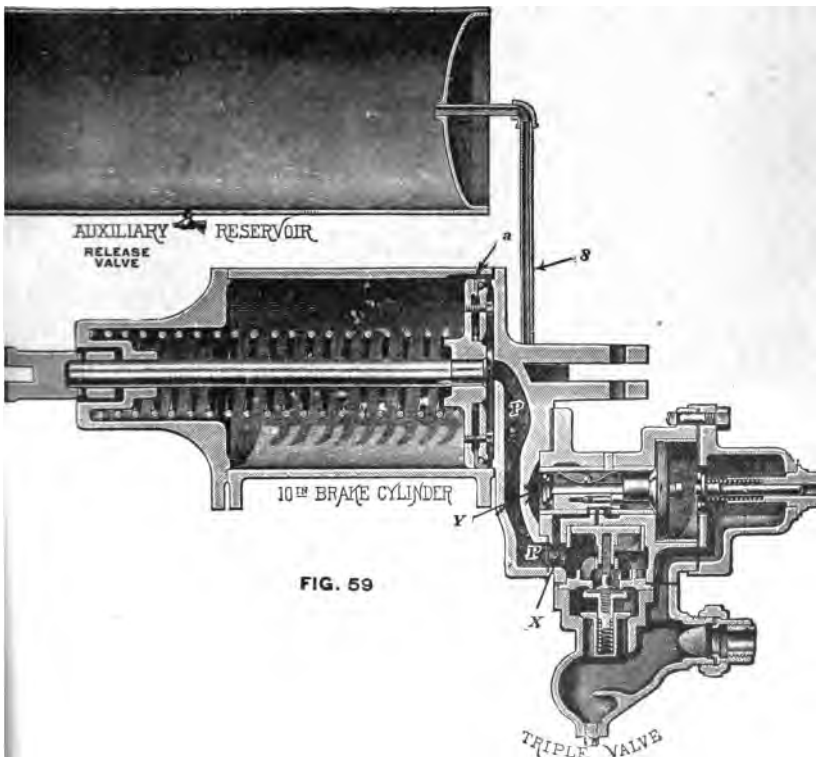


FIG. 59

the brake. To accomplish this purpose to the extent desired all the other parts of the air brake system are needed. Simple as the brake cylinder

appears, the object sought will not be accomplished if it is not in proper condition to perform its duty.

In Figures 59 and 60 appear the two standard types of brake cylinders. It will be noticed they are practically the same except the construction of the piston rods, which does not affect the principle of operation. The passenger brake cylinder Figure 59 has the piston rod fastened to the cross-

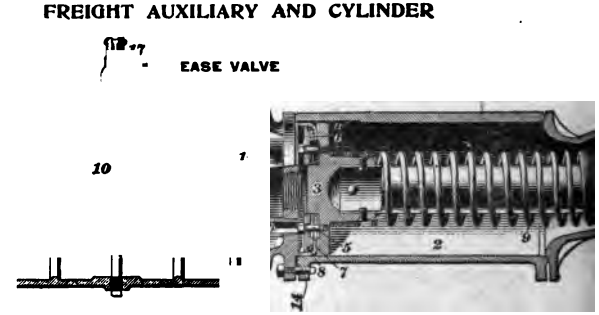


FIG. 60

head, and the crosshead fastened to the brake levers, so that every time the piston moves the brake levers also move. In the freight brake cylinder, Figure 60, the piston 3 is hollow, forming a sleeve into which is inserted a push rod (not shown in figure) which bottoms on the piston. To the outer end of this push rod is connected the brake levers. The purpose of this arrangement is that the hand brake can operate on the levers without moving the piston; the push rod simply being drawn out of the sleeve while the hand brake

is used. On passenger cars the brakes are so seldom applied by hand, that this arrangement is not deemed necessary.

Description.—(See Figure 60.) The brake cylinder 2 is bored smooth. The packing leather 7 is for making an air tight joint between the piston and the cylinder walls and is used in place of the ordinary packing ring. It is secured to the piston 3 by the follower 6 which is held by the studs and nuts 5. To insure the packing leather remaining in contact with the cylinder wall when no air pressure is in the cylinder, a heavy spring wire ring 8 is provided which acts as an expander.

The spring 9 is to force the piston head to "release" position when the brake is released and allows the brake shoes to drop away from the wheels. The head 4 serves to hold the piston rod central and forms a pocket to prevent the release spring 9 from being damaged in case the piston is allowed to overtravel. *b* is the pipe to convey the auxiliary air from the triple to the brake cylinder when the brake is applied. If the construction of the brake cylinder is thoroughly understood, its action will appear very simple. Air entering it from the auxiliary through the pipe *b*, forces the piston 3 out, which is connected to the brake lever applying the brake. When the triple permits the air to escape to the atmosphere the spring 9 forces the piston 3 to its normal position, releasing the brakes.

Leakage Grooves.—As has already been explained, the automatic brake is applied by a re-

duction in train-line pressure, and though there are always some leaks in the train-line, they are supplied by air from the main reservoir; but if this supply is cut off the leaks would reduce train-line pressure and the brakes would set. So to prevent, as far as possible, the brakes setting under these circumstances, each brake cylinder, except driver brake, is provided with a narrow groove *a*, Figures 59 and 60, extending from the pressure head to a short distance past the piston where the leather is in release position. Unless air enters the cylinder faster than it can leak by this groove the brake piston 3 will not be disturbed nor the brake applied. To apply the brakes air must enter the cylinder fast enough and in sufficient quantity to push the piston beyond the groove. Originally, the leakage grooves were placed at the top of all car cylinders, as shown in the illustrations, but they have been changed to the side. On some classes of cars it is more convenient to invert the cylinder, which with the old location of groove brought it at the bottom, and oil, which naturally drained to the bottom of the cylinder, was blown away and the leather packing soon dried out. This position also caused it to stop up with dirt and gum more quickly. The leakage groove is not, as many suppose, to prevent a leaky triple or a leak from the auxiliary into the brake cylinder from setting the brake as pressure reaching the brake cylinder in this way has always free access to the atmosphere through the triple exhaust, which is always open while the triple

is in release position. The leakage groove is only needed when a slight reduction or small leakage from train-line pressure has caused the triple to close the exhaust and slowly let air from the auxiliary into the brake cylinder, as when switching charged cars, a poor pump governor, excess pressure or feed valve allows the train-pipe pressure to vary; or when the engineer allows the brake handle to remain too long in full release overcharging the train, and then returns it to running position, which cuts off the train-line supply.

*Passenger and Freight Equipments.**—The arrangement of the triple valve, auxiliary-reservoir and brake cylinder differs for passenger and freight cars. This is on account of the limited space for them on freight cars, but the principle of operation is the same. The *passenger car* equipment is shown in Figure 59. The pipe 8 leads from chamber Y of the triple valve to the auxiliary-reservoir; air from the train-line flowing from the triple *to it* when recharging; and *from it* to the triple thence into the brake cylinder through passage P connected to the triple at X, when the brake is applied. When the triple is forced into release position, opening the triple exhaust, pressure from the brake cylinder returns to the triple through the passage P, and escapes to the atmosphere at the triple exhaust. In the

*Only Illustrations of the Westinghouse Equipments are shown, as these suffice for both; the New York arrangement being precisely the same.

freight car equipment, Figure 60, the triple valve is bolted to the auxiliary and no pipe is required as the pipe *b*, leading from the auxiliary-reservoir makes a very solid and compact arrangement.

SIZES OF BRAKE CYLINDERS AND AUXILIARY-RESERVOIRS USED ON DIFFERENT WEIGHTS OF EQUIPMENT.

Equipments.	Class of Service.	Approximate Light Weights for Cylinder, Sizes Specified.	Diameter of Cylinders.	Auxiliary Reservoir.
Driver Brake.	All Locomotives, with or without Truck Brake or High-Speed Attachments	..... to 40,000 lbs	8″	10″x33″
		40,000 to 85,000 "	10″	12″x33″
		70,000 to 115,000 "	12″	14″x33″
		110,000 to 170,000 "	14″	16″x33″
		145,000 to 225,000 "	16″	16″x42″
Tender.	Passenger-Engine Tenders	15,000 to 30,000 "	8″	10″x24″
		30,000 to 47,000 "	10″	12″x33″
		47,000 to 68,000 "	12″	14″x33″
	Freight and Switch-Engine Tenders	15,000 to 30,000 "	8″	10″x24″
		30,000 to 47,000 "	10″	12″x33″
		47,000 to 68,000 "	12″	14″x33″
Car.	Passenger Cars	15,000 to 30,000 "	8″	10″x24″
		30,000 to 47,000 "	10″	12″x33″
		47,000 to 68,000 "	12″	14″x33″
		68,000 to 92,000 "	14″	16″x33″
		92,000 to ..... "	16″	16″x42″
	Freight Cars	..... to 15,000 "	6″	Standard
		15,000 to 40,000 "	8″	Cast-Iron
		40,000 to ..... "	10″	Reservoir

The following table gives the forces exerted upon the pistons of the different sized cylinders with pressures of 50 and 60 pounds per square inch:

Size of cylinder.....	16″	14″	12″	10″	8″	6″
50 pounds pressure....	10,050	7,700	5,650	4,000	2,500	1,400
60 pounds pressure....	12,050	9,200	6,700	4,700	3,000	1,700

Large brake cylinders are advisable so that the required leverage of the car will not exceed nine—that is, the power exerted by the brake piston would not require to be increased more than nine times by the levers in order to give the necessary power at the shoes. This gives plenty of brake shoe clearance when brakes are released.

The cylinders should always be placed in as protected a position as possible without being inaccessible for cleaning and oiling or other repairs. On freight cars constructed for special service it is often advisable to alter the usual freight brake arrangement by separating the auxiliary-reservoir from the brake cylinder or even employing two cylinders—one for each truck of the car.

CHAPTER XII.

PISTON TRAVEL.

By piston travel is meant the distance the brake cylinder piston moves out when the brake is fully applied. To measure the travel, first be sure the head is bottomed in the cylinder. Make a mark on the piston rod at the edge of the cylinder head; apply the brake in full and measure from the cylinder head to the mark.

Standing Travel, is the distance the piston is forced outward in applying the brake upon a car when not in motion.

Running Travel, is the distance the piston is forced out in applying the brake upon a car when in motion. The running travel is always greater than the standing travel, the increase being due to slack in loose-fitting brasses, to the shoes pulling down upon the wheels, to play between boxes and pedestals, and to everything of a similar nature that increases lost motion in the brake rigging under the influence of the motion of the car.

False travel, is an excessive travel momentarily occurring while a car is in motion; it is due to unevenness of the track, or to some unusual temporary strain.

The brake cylinder pressure resulting from a given train-pipe reduction is greater with a short than with a long piston travel.

A piston travel of 8 inches results in a brake cylinder pressure of about 50 pounds, in a full service application. Inasmuch as running travel is generally about one and one-half inches greater than standing travel, the standing travel should be 6½ inches to secure this result while running.

If the piston travel is shorter than 8 inches the auxiliary and brake cylinder airs will equalize at a higher pressure and the brakes will be applied much harder. If the travel is more than 8 inches the auxiliary and brake cylinder airs will equalize at a lower pressure and the brakes cannot be applied nearly as hard. To illustrate this clearly, the following table is given, it being the result of careful tests made and the average of several trials are given:

Service reductions from a train-pipe pressure of 70 pounds.	PISTON TRAVEL.							
	4″	5″	6″	7″	8″	9″	10″	11″
	Pounds pressure in brake cylinder							
7 pounds	25	23	17½	13	10½	8		
10 pounds	49	43	34	29	23½	19½	17	14
13 pounds	57	56	44	37½	33	29	24	20
16 pounds			54	47½	41½	35	29	24
19 pounds				51	47	40	36½	32
22 pounds					50	47½	44	39
25 pounds							47	45
Emergency	62	61	59½	58½	57½	56½	55½	55

Explanation:—The first column on the left gives the pounds of reduction made in the train-pipe pressure. The row of figures across the top gives the inches at which the piston travel was set. The remaining figures give the pressure in the brake cylinder. Thus we see that with a 4 inch piston travel and only a 13 pound reduction, we get more braking power than is possible to be obtained with

a 9 inch piston travel and a 22 pound reductio

Where the piston travel varies throughout train, a sufficient train-pipe reduction must b made to fully apply the brakes having the longe piston travel; in releasing, the increasing trai pipe pressure will force the triple valve piston c the car with an 11-inch piston travel to relea position first, the one on the car with a 10-in travel next, and so on down, those with the sho est travel being applied with the greatest fo and releasing last.

It will be clear, therefore, that satisfactory op ation can only be secured by uniformity of pist travel upon all cars in a train. If the pist travel be unnecessarily long, the brake-cylind pressure is thereby reduced and the efficiency o the brakes correspondingly impaired; in addition a greater quantity of compressed air is consume in brake applications than would otherwise b necessary. If the piston travel be too short, it i apt to be accompanied by dragging of the brak shoes upon the wheels while the brakes are re leased, and by too high a brake-cylinder pressure with an accompanying liability of sliding wheels when the brakes are applied.

In adjusting piston travel, it should be care fully noted whether the brake beams are so hun as to be at the same height above the rail whe the car is light as when loaded, or are so hun that they are lowered when the car springs ar compressed through loading the car and are raise when the load is removed. If the brake beam

are always at the same height above the rail, it is safe to adjust the piston travel when the car is either light or loaded; but if the height of the beams varies according to the load in the car, it is best, whenever possible, to adjust the piston travel when the car is light.

Piston travel should be adjusted as uniformly as possible throughout a train, in which case each brake will more nearly do its share of work, there will be fewer flat wheels, and smoother braking will result.

CHAPTER XIII.

FOUNDATION BRAKE GEAR.

The term *"Foundation Brake Gear"* refers to the combination of levers, rods, brake beams and hand brake connections through which the brake cylinder transmits its force upon the brake shoes. Plates G3, G35, A-4 and A 5 Appendix show how the brake cylinder is secured to the body of the car; how the brake beams are hung to the truck frame; also how the levers and rods are joined together to complete the connection.

There are two styles of Foundation brake gear, i. e., the *Hodge* and *Stevens* systems, as are shown in the accompanying Figures.

Hodge System:—(Figure 61.) It will be seen to consist of two cylinder levers operated by the same brake cylinder, two *floating* or Hodge levers, two *live truck* levers, and two *dead truck* levers.

Stevens System:—(Figure 62.) It will be noticed that there are no *floating levers.* The *cylinder levers* are sufficiently long to allow them to be connected directly to the *live levers.*

In either instance when the air enters the brake cylinder, and pushes out the piston, the *cylinder levers* transfer the pressure to the *floating levers, live* and *dead* truck *levers,* thus pulling the brake shoes upon the wheels, offering friction or resistance tending to retard their rotation.

The *hand brake* is designed to be used when here is insufficient air to stop the car. It is also sed to retain the car when it is left on a side rack.

It is always best to so design the hand and air rakes that they shall "work together," that is, o that all the levers move in the same direction

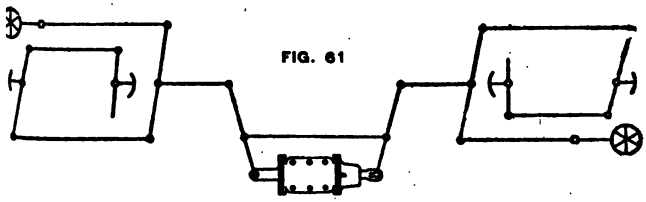


FIG. 61

HODGE SYSTEM
—OF—
CAR BRAKE LEVERS.

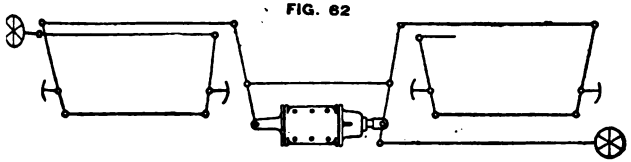


FIG. 62

STEVENS SYSTEM
—OF—
CAR BRAKE LEVERS.

hen the brakes are applied by hand as when plied by air. Where they "work opposite," or here hand power pulls against air power, only ie can be successfully used at a time, which is ry inconvenient where the air brake is applied on cars that are to stand for some time on a ade, since the hand brakes cannot be applied til the air brakes have been released. Many

other objections to such an arrangement occur in road practice, and brakes that "work together" are much to be preferred, from the standpoints of both practicability and safety.

It is important that the rods should be parallel with a longitudinal line through the center of the car, and the levers stand approximately at right angles to the rods, when the brakes are applied.

Brake beams should be so hung that the center of the brake shoes should be at the standard distance above the rail, as prescribed by the Master Car Builders' Association; and, wherever possible, the brake beams should be so hung that whether the car be light or loaded, they shall always be at the same distance above the rail. This practice greatly reduces the liability of flat wheels since the piston travel is not affected by the loading or unloading of the car and may therefore be properly adjusted whether the car be light or loaded.

Stiff Brake Rigging is essential to good brake construction, as light levers and brake beams will cause a considerable loss in brake power due to excessive piston travel and cause the car to pull very much harder on account of the small brake shoe clearance when the brake is not applied.

To insure a sufficiently strong, durable and substantial brake gear, the size of rods, levers, and pins recommended by the Master Car Builders' Association should be strictly followed.

Braking Power, is the pressure applied to the brake shoe, called shoe-friction. Experience has

demonstrated that the friction of brake shoes must not be greater than the adhesion of the wheel on the rail. If the brake shoe friction is too great the wheels will slide, which causes them to flatten, and also lengthens the stop.

The following percentages of their light weights empty) have been considered good practice for braking power on the different vehicles of trains:

Passenger cars 90 per cent.; freight cars 70 per cent.; tenders 100 per cent.; driver brakes 75 per cent. (of weight upon drivers, as the locomotive stands ready for service); truck brakes, 75 per cent. of weight upon the truck.

Unbraked Weight.—The most modern method of braking passenger cars is to use a certain unbraked weight, say 1500 pounds per axle and use the balance as braking power. This will make a uniform margin on all weights of cars to keep from sliding wheels. With the *90 per cent. method,* 10 per cent. of *light* passenger cars being much less than 10 per cent. of *heavy* cars, the former are the most liable to slide. For example, two cars, 4 wheel trucks weighing 40,000 and 80,000 pounds respectively 10 per cent. of the first is 4,000 lbs., or 1,000 pounds per axle, while the second is 8,000 lbs., or 2,000 pounds per axle. 1,500 pounds is a practical unbraked weight. Using this figure the total of the four pairs of wheels under each car would be 6,000 pounds. 6,000 pounds from 40,000 and 80,000 pounds leaves 34,000 and 74,000 pounds respectively for braking power. 34,000 is 85 per cent. of a 40,000 pound car while 74,000 would be 92½ per cent. of 80,000 pound car.

Leverage, is the term applied to the action o a lever, or the mechanical advantage gained by th use or operation of a lever. A lever is a mechan cal bar used to exert a pressure or sustain weight at one point of its length, by receiving force or power at a second point, and turning at third fixed point called a fulcrum. Levers are o three kinds; i. e. first, second and third clas Levers are used under cars to transfer and mu tiply the pressure upon the brake piston in rati to the desired amount required upon the brak shoes. The leverage of an air brake should neve be over 9 to 1, so that the brake shoes will hav plenty of clearance when the brake is off. Thi means that as the brake piston travels 9 inche the brake shoes will move 1 inch, minus of cours the deflection of brake beams, spring of levers rods and the lost motion in the running gear o the car. Where any sized cylinder is too small t cause the low leverage desired, the next larger siz should be used.

Figure 62*a* (X Y Z) shows the application of th three classes of levers used to exert pressure o the brake shoe in different requirements.

X represents a lever used as first class, Y th same lever used as second class, while Z is ar ranged to show its application as a third clas With any class of lever the strain at the middle i always equal to the sum of the strains at the tw ends. The power developed by any one of th three levers depends upon the relative position o the force, weight and fulcrum. If it is desired t

find out the braking p... of ..., n
if the equipment has a n or ...tic tr
valve, obtain the size of t ...in r, t
and dimensions of the lev a t t of
car, four or six wheel tru with or thout all
wheels braked.

FIG. 62a
LEVERAGE WITH FORMULA
VIEW X, Y AND Z

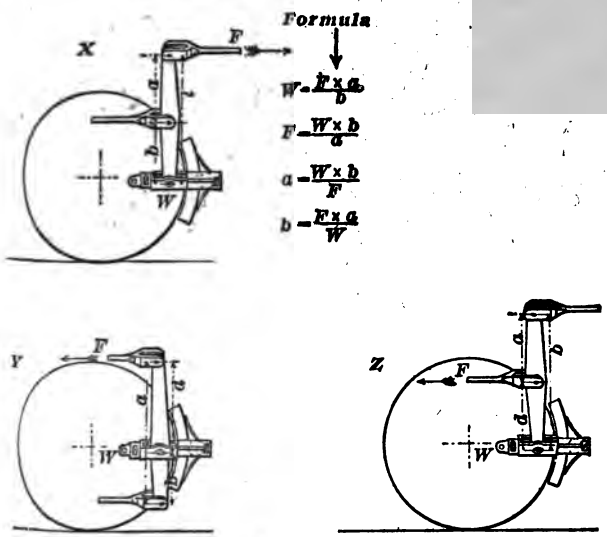


Figure 63 shows the plan of the foundation brake gear of a freight car. As the car weighs 34,286 pounds and the emergency braking power is 70 per cent. of the light weight, the pressure from the four brake beams upon the wheels must be 24,000 pounds or 6,000 pounds per beam. The

Leverage, is the term applied to the action (a lever, or the mechanical advantage gained by tl use or operation of a lever. A lever is a mechan cal bar used to exert a pressure or sustain weight at one point of its length, by receiving force or power at a second point, and turning at third fixed point called a fulcrum. Levers are three kinds; i. e. first, second and third cla Levers are used under cars to transfer and m- tiply the pressure upon the brake piston in ra- to the desired amount required upon the bra shoes. The leverage of an air brake should ne be over 9 to 1, so that the brake shoes will ha plenty of clearance when the brake is off. Th means that as the brake piston travels 9 inch the brake shoes will move 1 inch, minus of cours the deflection of brake beams, spring of lever rods and the lost motion in the running gear c the car. Where any sized cylinder is too small t cause the low leverage desired, the next larger siz should be used.

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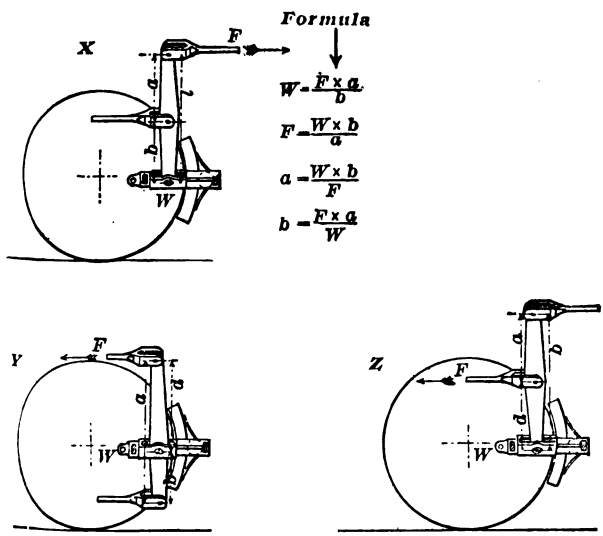
find out the braking power of any car, ascertain if the equipment has a plain or quick action triple valve, obtain the size of brake cylinder, the style and dimensions of the levers, and the weight of car, four or six wheel truck with or without all wheels braked.

FIG. 62a
LEVERAGE WITH FORMULA
VIEW X, Y AND Z



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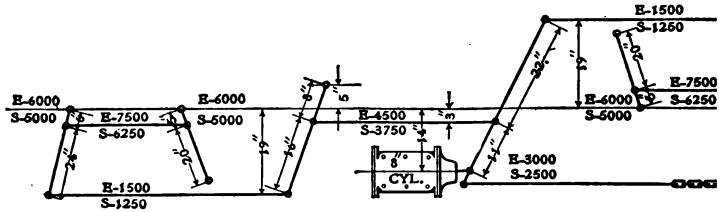
delivered force W at the lower end of the l lever must be 6,000 pounds; the middle pin is fulcrum; the distance *b*, from the fulcrum to delivered force is 6 inches and the distance from the fulcrum to the applied force F at upper pin is 24 inches. Substituting these val of W, *a* and *b* is the Formula $F = \frac{W \times b}{a}$, the fo

FIG. 63

Weight of Car, 34,286 pounds; Braking Power, 24,000 pounds, or 70 per

With the Quick-Action Triple Valve, E indicates forces in Emergency Applic indicates forces in Full Service Applications; with the Plain Triple Valve, S i the forces in either Full Service or Emergency Applications.



All Distances of Rods from Center Line of Car Body are those that should occ Levers stand at Right Angles to it.

that must be applied at the upper pin by t upper rod is $F = \frac{6000 \times 6}{24} = 1{,}500$ pounds.

To find the force delivered by the live lever, the dead lever, the lower pin becomes the fulcru 1,500 is the applied force F, at the upper pin inches *a* from the fulcrum, and the deliver force *w*, is 6 inches *b*, from the fulcrum. The fore $W = \frac{F \times a}{b} = \frac{1500 \times 30}{6} = 7{,}500$ pounds.

The correctness of this result is checked by a ing the forces (1,500 pounds and 6,000 pound

acting at the upper and lower pins, respectively, which must equal the force at the middle pin. The force applied to the middle pin is thus found to be 7,500 pounds.

In order that it may clear the upper rod, the dead lever is made but 25 inches long. The upper pin is the fulcrum and a force of 6,000 must be delivered to the brake beam at the lower pin, 25 inches from the fulcrum and a force of 7,500 pounds applied at the middle pin; that is, F= 7,500, W=6,000 and b=25. Therefore $a = \frac{W \times b}{F} = \frac{6000 \times 25}{7500} = 20$ inches. The middle pin must be 20 inches from the upper pin and 5 inches from the lower pin.

The lower end of each lever is one-fourth the length of the upper end, therefore they are in proper proportion. Since the top ends of the live levers and the outer ends of the cylinder and floating levers are connected, a force of 1,500 pounds must be delivered at the outer end of the cylinder and floating levers.

The cylinder lever is 33 inches long. The cylinder being 8 inches in diameter, the emergency air pressure upon the piston is 3,000 pounds. The strain on the middle pin hole must be 1,500 pounds $-$ 3,000 pounds $=$ 4,500 pounds. To find out where the middle pin hole should be, let the outer end of cylinder lever be the fulcrum, 3,000 is the applied force F, at the cylinder end 33 inches a from the fulcrum, and the delivered force W, 4,500 is b inches from the fulcrum. Applying the formula $b = \frac{F \times a}{W} = \frac{3000 \times 33}{4500} = 22$=inches,

delivered force W at the lower end of the l lever must be 6,000 pounds; the middle pin is fulcrum; the distance *b*, from the fulcrum to delivered force is 6 inches and the distance from the fulcrum to the applied force F at upper pin is 24 inches. Substituting these val of W, *a* and *b* is the Formula $F = \frac{W \times b}{a}$, the fo

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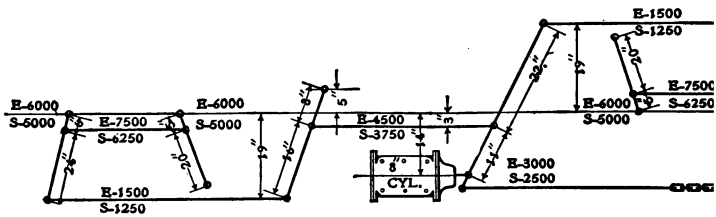

All Distances of Rods from Center Line of Car Body are those that should occ Levers stand at Right Angles to it.

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acting at the upper and lower pins, respectively, which must equal the force at the middle pin. The force applied to the middle pin is thus found to be 7,500 pounds.

In order that it may clear the upper rod, the dead lever is made but 25 inches long. The upper pin is the fulcrum and a force of 6,000 must be delivered to the brake beam at the lower pin, 25 inches from the fulcrum and a force of 7,500 pounds applied at the middle pin; that is, F= 7,500, W=6,000 and b=25. Therefore $a = \frac{W \times b}{F} = \frac{6000 \times 25}{7500} = 20$ inches. The middle pin must be 20 inches from the upper pin and 5 inches from the lower pin.

The lower end of each lever is one-fourth the length of the upper end, therefore they are in proper proportion. Since the top ends of the live levers and the outer ends of the cylinder and floating levers are connected, a force of 1,500 pounds must be delivered at the outer end of the cylinder and floating levers.

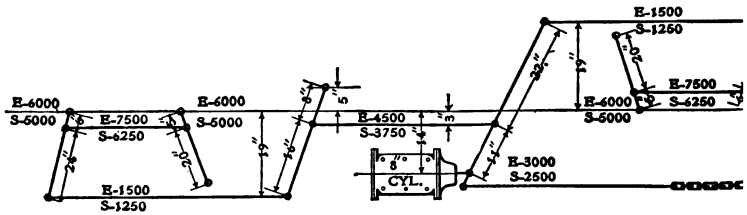
The cylinder lever is 33 inches long. The cylinder being 8 inches in diameter, the emergency air pressure upon the piston is 3,000 pounds. The strain on the middle pin hole must be 1,500 pounds $-$3,000 pounds $=$ 4,500 pounds. To find out where the middle pin hole should be, let the outer end of cylinder lever be the fulcrum, 3,000 is the applied force F, at the cylinder end 33 inches a from the fulcrum, and the delivered force W, 4,500 is b inches from the fulcrum. Applying the formula $b = \frac{F \times a}{W} = \frac{3000 \times 33}{4500} = 22$=inches,

delivered force W at the lower end of the live lever must be 6,000 pounds; the middle pin is the fulcrum; the distance *b*, from the fulcrum to the delivered force is 6 inches and the distance *a* from the fulcrum to the applied force F at the upper pin is 24 inches. Substituting these values of W, *a* and *b* is the Formula $F = \frac{W \times b}{a}$, the force

FIG. 63

Weight of Car, 34,286 pounds; Braking Power, 24,000 pounds, or 70 per cen

With the Quick-Action Triple Valve, E indicates forces in Emergency Applicatio indicates forces in Full Service Applications; with the Plain Triple Valve, S indi the forces in either Full Service or Emergency Applications.



All Distances of Rods from Center Line of Car Body are those that should occur Levers stand at Right Angles to it.

that must be applied at the upper pin by the upper rod is $F = \frac{6000 \times 6}{24} = 1{,}500$ pounds.

To find the force delivered by the live lever, to the dead lever, the lower pin becomes the fulcrum 1,500 is the applied force F, at the upper pin 30 inches *a* from the fulcrum, and the delivered force *w*, is 6 inches *b*, from the fulcrum. Therefore $W = \frac{F \times a}{b} = \frac{1500 \times 30}{6} = 7{,}500$ pounds.

The correctness of this result is checked by adding the forces (1,500 pounds and 6,000 pounds

acting at the upper and lower pins, respectively, which must equal the force at the middle pin. The force applied to the middle pin is thus found to be 7,500 pounds.

In order that it may clear the upper rod, the dead lever is made but 25 inches long. The upper pin is the fulcrum and a force of 6,000 must be delivered to the brake beam at the lower pin, 25 inches from the fulcrum and a force of 7,500 pounds applied at the middle pin; that is, F= 7,500, W=6,000 and b=25. Therefore $a = \frac{W \times b}{F} = \frac{6000 \times 25}{7500} = 20$ inches. The middle pin must be 20 inches from the upper pin and 5 inches from the lower pin.

The lower end of each lever is one-fourth the length of the upper end, therefore they are in proper proportion. Since the top ends of the live levers and the outer ends of the cylinder and floating levers are connected, a force of 1,500 pounds must be delivered at the outer end of the cylinder and floating levers.

The cylinder lever is 33 inches long. The cylinder being 8 inches in diameter, the emergency air pressure upon the piston is 3,000 pounds. The strain on the middle pin hole must be 1,500 pounds + 3,000 pounds = 4,500 pounds. To find out where the middle pin hole should be, let the outer end of cylinder lever be the fulcrum, 3,000 is the applied force F, at the cylinder end 33 inches a from the fulcrum, and the delivered force W, 4,500 is b inches from the fulcrum. Applying the formula $b = \frac{F \times a}{W} = \frac{3000 \times 33}{4500} = 22$=inches,

33—22=11 inches for the other end. It is very necessary that the floating and cylinder levers be proportioned exactly alike, though their lengths be quite different. If the levers are proportioned properly the force delivered to each of the upper rods will be exactly alike. In this case the cylinder lever is 33 inches long while the floating lever is 24. To find the middle hole, 4,500 is the applied force F, located *a* inches from the fulcrum and 1,500 is the delivered force W, 24 inches *b* from the fulcrum. Apply the formula $\frac{a = W \times b}{F}$ $= \frac{1500 \times 24}{4500} = 8$ inches. 24—8=16 inches.

The short ends of both cylinder levers are exactly one half the length of the long ends, therefore they are in proportion. Thus the levers are correct.

If the same car was already equipped with the air brake and it is desired to ascertain the braking power, we should pursue a reverse course. Starting with the known emergency piston pressure of 3,000 pounds as the applied force F, at the end pin of the cylinder lever, the middle pin is the fulcrum, $a = 11$ and $b = 22$, therefore $W = \frac{F \times a}{b} = \frac{3000 \times 11}{22} = 1{,}500$ pounds delivered to the upper rod.

Since the floating lever has the same proportions as the cylinder lever, we know without further calculation, that a force of 1,500 pounds is also delivered by the floating lever to the other upper rod. As it is, knowing that 1,500 is the force F applied to the upper pin of each live truck lever, we have only to trace the forces

through one truck. The applied force F at the upper pin of the live truck lever is 1,500 pounds and the middle pin is the fulcrum, so that, in determining the force W delivered to the beam, $a = 24$ and $b = 6$. Therefore, $\frac{W = F \times a}{b} = 1{,}500 \times \frac{24}{6} = 6{,}000$ pounds, which is the force applied by the brake beam.

As the dead lever is proportioned exactly like the live lever we know without further calculation that the same force 6,000 pounds is applied to each brake beam, and the total braking power of the car is $6{,}000 \times 4$ or 24,000 pounds, which divided by the weight of the car (34,286 pounds) is .70—the per cent. braking power.

The forces above calculated and shown upon the diagram of Figure 63 represent an emergency application and are designated by the letter E. In a full service application, the air pressure upon the piston of the 8-inch brake cylinder is but 2,500 pounds, and the forces thereby developed throughout the brake gear are designated by the letter S upon the same diagram. The calculation of these forces is left as an exercise for the interested reader. It may be observed, also, that, where the plain triple valve is employed, the forces designated by the letter S occur in emergency as well as in service applications.

Extreme care should be used to distinguish between levers of the different classes. Where the brake beam is attached to the bottom of the truck lever, it is used as a lever of the first class; where the brake beam is attached to the middle hole of

33—22=11 inches for the other end. It is very necessary that the floating and cylinder levers be proportioned exactly alike, though their lengths be quite different. If the levers are proportioned properly the force delivered to each of the upper rods will be exactly alike. In this case the cylinder lever is 33 inches long while the floating lever is 24. To find the middle hole, 4,500 is the applied force F, located a inches from the fulcrum and 1,500 is the delivered force W, 24 inches b from the fulcrum. Apply the formula $\frac{a = W \times b}{F}$ $= \frac{1500 \times 24}{4500} = 8$ inches. 24—8=16 inches.

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rake beam is attached to the middle hole of

the lever its application would be one of secor class. In the figure used as our design for expla ation it will be noted that it is a first class leve 4 to 1, if the brake beam had been connected the middle hole the same lever would be 5 to giving a higher braking power.

Driving Wheel Brakes.—The importance o maintaining good driver brakes cannot be to strongly emphasized, in view of the fact tha driver-brake power developed upon a consolida tion engine, weighing 150,000 pounds on th drivers, is 112,500 pounds. A 60,000 pound capac ity wooden car usually weighs about 30,000 pound and has a braking power of 70 per cent., or 21,00 pounds. It thus appears that the driver brak alone furnishes more braking power than five such 60,000 pound capacity cars.

A well maintained driver brake with flange shoes will keep the tires dressed and in good con dition much longer than where the brake receives scant attention.

The driver brake is usually arranged with two cylinders of proper size, one on each side of the engine frame. Each cylinder is connected to its individual levers to operate the brake on that par ticular side. The air pipes are so arranged that one triple valve and auxiliary reservoir can fur nish equal air pressure to both cylinders at the same time, when the brake is applied. The pistor travel of each cylinder is set at about one-half the travel of a car brake cylinder so that the auxiliary and brake cylinder pressures will equalize at 5

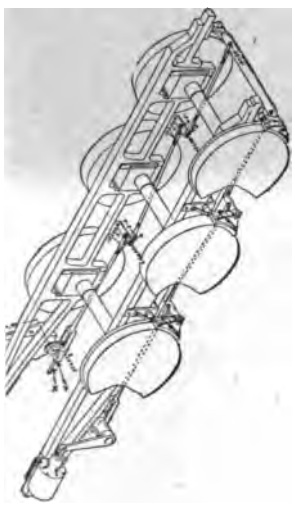
ıds with the usual 20 pound brake applica-

There are two styles of driver brakes, ıerican Outside Equalized" and "Cam" type. 's of both are shown in the Appendix, Styles and F.

ıerican Equalized Driver Brake:—This style ake is generally used where there are more two pairs of drivers.

gure 64 shows a skeleton view of the "Ameri- Equalized Brake" as applied to a six-wheel connected engine, showing the distribution of braking power. The piston of each brake cylinder is connected to the top end of the bell - crank lever which turns in the fulcrum attached to the engine frame; the bottom end of the lever is connected to the brake rods. As the brake is applied the piston moves forward, thus pulling the backward, bringing the brake shoes to the ls. The manner of computing the braking r for *Outside Equalized Brakes* is as fol- : Multiply the cylinder value, or total push ston, by the long lever arm, and divide this

4. AMERICAN DRIVER BRAKE



ıMERICAN EQUALIZED DRIVER BRAKE.

product by the short lever arm. The result multiplied by 2 gives the total braking power. In the figure a total force of 7,650 pounds is represented at the top end of lever *a*. $7{,}650 \times 24 = 183{,}600 \div 6 = 30{,}600$, or the pull at the bottom end of lever *a*. This all goes to the lever *b*. Lever *b* is made a proportion of 2 to 1, therefore the pressure is divided so that 10,200 pounds goes to the brake shoe, and 20,400 pounds to the lever at *c*. Lever *c* being equally divided, 10,200 pounds goes to the brake shoe there, while 10,200 is transmitted to the brake beam at *d*.

There being brakes on both sides of the engine, $30{,}600 \times 2 = 61{,}200$ pounds, total braking power. 61,200 pounds $\div$ 75 per cent. $=$ 81,600 pounds, total weight of the engine for which this particular brake is designed.

The piston travel is adjusted by the screw X and lock nut Y at the back end of the rod that connects to the lever *a*.

Cam Driver Brakes:—(Style A Appendix.) The Cam Driver brake is practically a spread brake of the push down type. Air is admitted into the top of each cylinder. As the piston travels down it pushes on the crosshead and links, and consequently, the cams are caused to roll on each other and move the cam screw pins outward, pressing the brake shoes against the wheels. The brake is adjusted by changing the length of the cam screw between the cam and the lever.

To shorten the piston travel the screws are adjusted to spread the brake levers farther apart.

The cam brake should be adjusted so that the point of contact of the cams will be in line with the center of the brake cylinder. Sufficient shoe clearance should be allowed, as the rolling of the engine is liable to cause the brakes to bind upon the wheels.

To calculate the braking power, apply the brake and measure the piston travel; then release the brake, insert pieces of ¼-inch steel wire crosswise between the tire and one shoe at the upper and lower ends, and again apply the brake; divide the difference of the piston travel by the thickness of the wire, and multiply the result by the total force acting upon the piston. The result is the pressure of this one shoe, which, multiplied by 4, gives the total braking power. Divide the total by the weight on the drivers to obtain the percentage of braking power.

Example:

Weight on drivers, 53,330;

Piston travel, without inserting wires, 3 inches;

Piston travel, with ¼ inch wires inserted, 2 inches;

Total force on piston (8 inch cylinder brake, fully applied), 2,500 pounds.

$1 \div \frac{1}{4} = 4$. $4 \times 2{,}500 = 10{,}000$ pounds.

10,000 pounds $\times$ 4 = 40,000 pounds, the total braking power.

$40{,}000 \div 53{,}330 = 75$ per cent.

NOTE:—The subject of brake shoes is fully treated in another volume of "The Science of Railways" series, devoted to the subject of cars.

CHAPTER XIV.

RETAINING VALVE.

The purpose of the retaining valve is to ret the release and finally retain a pressure of pounds in the brake cylinder when the engineer

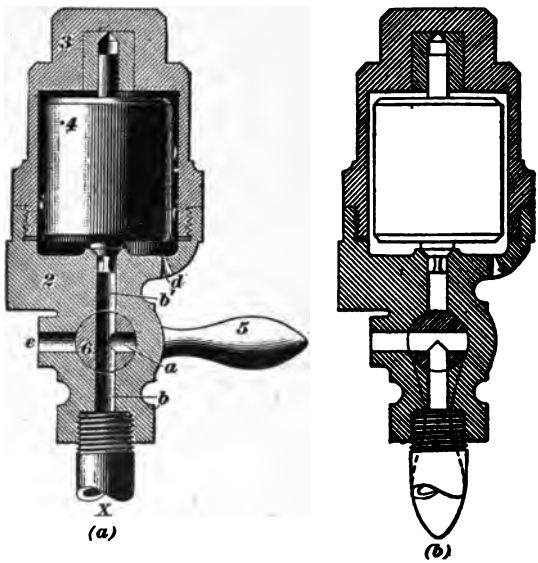


FIG. 65

RETAINING VALVE

recharging the auxiliary preparatory to anot application of the brakes, while descending grade. Figures 65 and 66 are views for referer

is composed of a weighted valve and a small ee way cock. The retainer is connected by the e X to the exhaust port of the triple valve; is all the air exhausted from the brake cylin- by the triple must at all times pass through the retainer to the atmosphere. We will now suppose the handle 5 of the retainer is in the position shown in view *b*, the pressure from the brake cylinder has an unobstructed passage to the atmosphere, thus allowing the brake to release fully. But in coming down mountain grades it is desirable that the brakes be kept partly applied while the en-

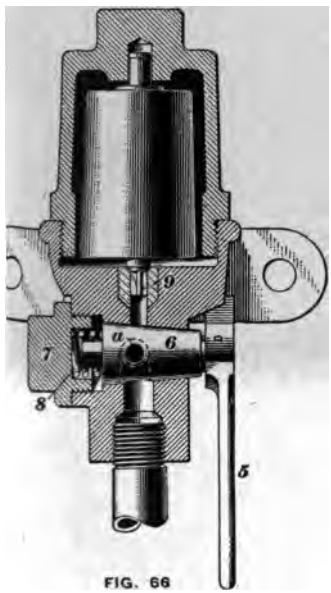


FIG. 66

er releases to recharge the auxiliaries and prevent the speed of the train from increas- too rapidly. This is done by the train-men g over the top of the cars and turning up the iner handles 5 on all the cars on which the es are desired to be retained. It will now be by referring to view (*a*) that the pressure the brake cylinder has an unobstructed pass-

pounds. When the handle is placed in the horizontal position, marked "low pressure," one of two eccentric lugs on it raises lifting pin 9, and also the outside weight, the latter to the top of its movement. During

FIG. 66C

such time the inner weight alone retains only the low pressure of 15 pounds. If the handle is placed in the intermediate position marked "high pressure," (Fig. 66-C), neither eccentric lug touches the lifting pin, and consequently the outside weight rests upon the top of

the inner one, and the air pressure must raise both weights before it can escape to the atmosphere. When the handle is placed vertically downward, as shown in the cut, the air passes directly to the atmosphere, thus cutting out the retaining valve, while at the same time the other eccentric lug on the handle raises the lifting pin and outside weight, so that the small weight alone rests on the valve seat, and wear is reduced to a minimum.

It will be noted that the exhaust and low pressure position of this retaining-valve handle are similar to those of the standard retaining valve. This is done so that when cars equipped with this valve are running in localities free from heavy grades, and the train crews may not be familiar with this new type of valve but are so with the standard valve, they cannot by mistake place the handle in the high pressure position. It will be noted also that the letters "H. P." and "L. P." are cast on the body so as to still further assist in indicating the positions of the valve handle.

The development of this device was coincident with a series of interesting and valuable tests made by a leading railway company with a view of determining what is actually required to hold such heavy trains under perfect control when descending heavy grades, through using higher air pressures, special pressure-retaining valves, water brake on the locomotive, and the Westinghouse Combined Automatic and Straight-Air Brake equipment on the locomotive and tender. The results of these tests indicate that to suitably control such trains, the minimum brake-pipe and auxili-

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ary-reservoir pressures should not fall below 70 pounds in order to give sufficient reserve braking power to stop the train in cases of emergency on a heavy grade.

The Pressure-retaining valve was in all cases placed in the 30-pound position, and it was found that under these conditions the train was in perfect control at all times.

CHAPTER XV.

AUTOMATIC SLACK ADJUSTER.

The Automatic Slack Adjuster is a simple mechanism, by means of which a desired piston travel is constantly maintained, compelling the brakes of each car to do their full amount of work—no more and no less—thus securing from the brakes their highest efficiency, without the flat wheels which are likely to accompany a wide range of piston travel. As the brake shoes wear and piston travel increases this device takes up the slack of the *Foundation gear* and establishes the *running* piston travel; that is, the piston travel occurring when the brakes are applied while the car is in motion; and, since this is the time during which the brakes perform their work, the running travel is the important one.

The Automatic Slack Adjuster is illustrated by Figures 67 and 68 and its operation is very simple. The brake-cylinder piston acts as a valve to control the admission and release of brake-cylinder pressure to and from pipe *b* (Figure 67) through port *a* in the cylinder, this port being so located that the piston uncovers it when the piston travel is exceeded. Port *a* is just 8⅜ inches from the pressure cylinder head. The piston packing

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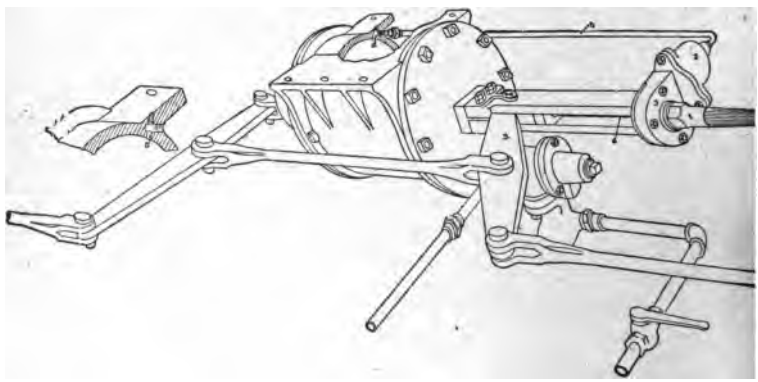
leather laps over ⅜ of an inch, thus leaving 8 inches which determines the piston travel. Port *a* should be drilled as in Figure 67. Whenever the piston uncovers port *a*, brake-cylinder air flows through pipe *b* into slack-adjuster cylinder 2, where the small piston 19 (Figure 68) is forced outward, compressing spring 21. Attached to piston stem 23 is a pawl 22 extending into casing 24, which engages ratchet wheel 27, mounted within



AUTOMATIC SLACK ADJUSTER.
FIG. 67

casing 24 upon screw 4 (Figure 67). When the brake is released and the brake cylinder piston returns to its normal position, the air pressure in cylinder 2 escapes to the atmosphere through pipe *b*, port *a* and the non-pressure head of the brake cylinder, thus permitting spring 21 to force the small piston to its normal position. In so doing,

the pawl turns the ratchet wheel upon screw 4, and thereby draws lever 5 slightly in the direction of the slack-adjuster cylinder, thus shortening the brake-cylinder piston travel and forcing the brake shoes nearer the wheels. As the pawl is drawn back to its normal position, a lug on the lower side strikes projection *a* (Figure 68) on the cylinder, thus raising the outer end cf the pawl, disengaging it from the ratchet wheel, and permitting the screw to be turned by hand if desired.

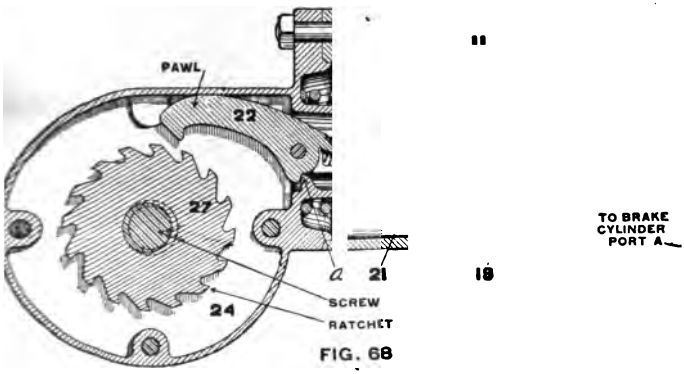


FIG. 68

AUTOMATIC SLACK ADJUSTER.

To apply new shoes, turn casing 1 to the left, thus moving lever 5 toward the position shown on Figure 67 until sufficient slack is introduced in the brake rigging. To bring the shoes closer to the wheels and shorten the piston travel, turn casing 1 to the right.

The screw mechanism is so proportioned that the piston travel is reduced only about 1/32 of an

inch in each operation, which removes danger of unduly taking up false travel.

To avoid the necessity of a bracket to support the adjuster, a special cylinder head, provided with a suitable lug, has been designed for that purpose, and is now furnished with truck, tender, and car cylinders, unless other styles be specified.

After the slack adjuster has been applied and the pipe tested for leaks, sufficient slack should be introduced in the brake gear, by means of the adjuster, and an entire new set of shoes applied. The slack should then be taken up, by turning casing 1 to the right, until the standing piston travel is from six to six and one-half inches, care being exercised to distribute the slack equally on both trucks by giving about the same angle to the dead levers. When the brake gear of a car, having proper total leverage, is thus equalized, the adjuster will maintain a constant piston travel until a full set of shoes has worn out, without any necessity of changing the position of the dead levers.

If the piston travel becomes too short, it will be found that either some of the slack in the brake rigging has been taken up by the hand brake where the two work in opposition, or the dead levers have been moved.

If the piston travel is found to be too long, when the small pipe leading to the adjuster cylinder is free from obstruction and the packing leather in the adjuster cylinder is free from leakage, it is more than probable that the slack has been taken up through an application and only partial release

of the hand brake, and subsequent full release occurred only after the shoes had had time to wear more or less.

The best results are obtained by the use of copper pipe from the brake cylinder to the adjuster cylinder, since this pipe is more flexible and does not corrode. It should always be firmly secured.

CHAPTER XVI.

AIR SIGNALING SYSTEM.

The general arrangement of the train ai naling apparatus on air engine tender and p ger car is shown in Plates F-33 and A-3, A dix. The object of the air signal is to tak place of the old bell-cord and gong method o veying signals from the train to the engin passenger trains. The signal line pipe whi tends throughout the entire train is ¾ incl connected between cars by means of hose si to those used for the brake system. A ca charge valve is provided on each car and gen is located and piped as shown in the illustr A signal cord is attached to the lever 5, Fig of the discharge valve and extends the length of the car, being fastened to the ho each end, thus enabling a signal to be given any part of the car. The engine apparat addition to the necessary piping, consists *pressure reducing valve* (Figure 3), *signal* (Figure 2), and a *signal whistle* (Figure 4) shown in cab diagram.

Pressure Reducing Valve.—A cross-s view of the New York reducing valve is s The old style Westinghouse was ident the same; therefore, a description of one

suffice for both. Referring to the New York valve (Figure 3, Plate A-3, Appendix), the main reservoir connection is made at the bottom and that leading to the signal system is connected at the side. As it is not desirable or necessary to have as high a pressure in the signal system as in the brake system the function of the reducing valves is to prevent the pressure in the signal system raising above the desired amount, 40 pounds. Main reservoir pressure, entering the reducer, is free to pass through the valve until the pressure in the signal line and chamber A exerts an upper pressure, against the diaphragm 7 and plate 8, slightly more than the downward pressure of spring 9. The pressure on the lower side of the diaphragm 7 now being the greater will cause it to be forced upward, and the supply valve spring 10 forces the supply valve 5 to its seat, and prevents any more air from the main reservoir from entering the signal system. When the pressure in the signal system becomes slightly reduced through leakage or on account of a discharge having been made at the car discharge valve, the spring 9 again forces the valve 5 from its seat, and pressure from main reservoir again feeds into the signal system to supply the pressure lost. The tension of the regulating spring 9 is set to withstand a pressure of 40 pounds before it will compress, thus the pressure in the signal system is prevented from exceeding that amount. Should the spring 9 become weakened, so as to cause the signal system pressure to fall

below 40 pounds, the tension of the spring may be increased by placing a washer between it and the cap 3. The proper lift of the supply valve is 1/16 inch. The two outlets in the cap 3 are so that any pressure leaking past the diaphragm can escape to the atmosphere, otherwise it would accumulate above the diaphragm and render the valve inoperative.

The Westinghouse Improved Pressure Reducing Valve is shown in Figure 3 Plate F-33, Appendix. Its construction is similar, and its principle of operation the same as the New York and old style Westinghouse. The improvement includes the addition of a piston 7 and packing ring 8 above the double rubber diaphragm, also a means of regulating the tension of the spring 9 by adjusting the regulating nut 14. A cut-out plug cock (shown in cross section) is also added. The improved reducer can be cut out and cleaned by removing cap nut 5.

Car Discharge Valve.—The construction of the Westinghouse and New York car discharge valves are precisely the same. A sectional view of the valve is shown in Figure 1, Plate F-33 and A-3, Appendix. The object of the car discharge valve is to provide a means of quickly reducing the pressure in the signal line, in order to cause the action of the *signal valve,* which will be explained under a following head. The union (shown to the left of the valve), to which the branch pipe from the signal pipe is coupled, connects with the discharge valve as shown by the

circular dotted line. The exhaust port is just above valve 3 and leads to the atmosphere.

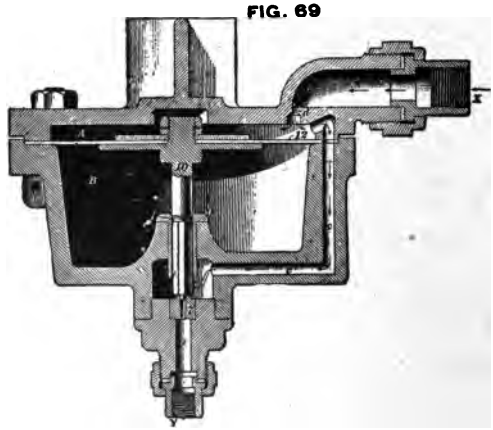
When the signal cord, fastened to the lever 5, is pulled on either side the lower portion of the lever 5 strikes the stem of the discharge valve 3 and forces it from its seat. As the signal line pressure is constantly in the chamber around the valve 3, it escapes to the atmosphere, past the valve and out the exhaust port, thus causing a reduction of signal line pressure. As soon as the signal cord is released, the valve is forced to its seat again by the spring 4, and stops the discharge of air.

Signal Valve.—Although the Westinghouse and New York signal valves are the same in principle of action, they are somewhat differently constructed. They will therefore be treated separately. The action of the signal valve is what causes the signal whistle on the engine to blow. *Westinghouse:* A sectional view of the Westinghouse signal valve is given in Figure 69. The signal line connection is made at X, and the pipe leading to the signal whistle is connected at Y. Air pressure from the signal pipe enters the valve through the small port *d,* and fills chamber A above the rubber diaphragm 12. It also fills the passage *c, c,* and feeds up slowly past the stem 10 into chamber B, until the pressure in chambers A and B, on both sides of the rubber diaphragm, become equal. When the signal cord is pulled, causing a reduction of pressure in chamber A, above the diaphragm 12, and the pressure in chamber B

forces the diaphragm 12 upward, carrying with it the stem 10, this opens *e* and brings the groove *f*, in the stem 10, above the bushing 9. The pressure in chamber B escapes quickly down through the milled spaces in the stem 10 into the passage *e*, which leads to the signal whistle. Air also escapes from the train-pipe through the chamber A and

WESTINGHOUSE SIGNAL VALVE

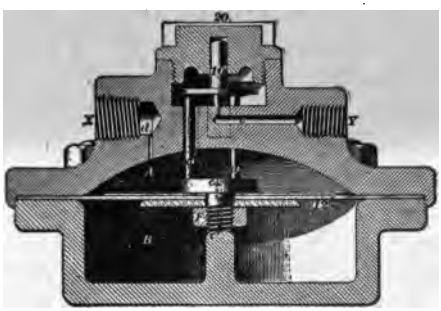
FIG. 69



passage C, C, to the whistle. When a reduction is made in the signal pipe, there are two reasons why the pressure reduces faster in chamber A than in chamber B: (1) the fit of the stem 10 in the bushing 9 is such that it makes a smaller opening than the port *d;* (2) the space in chamber B being so much larger contains a greater volume of air, and would therefore reduce much slower even if the openings were the same. When the car dis-

charge valve closes air from the main reservoir restores the signal line pressure, which increases in chamber A faster than in chamber B, thus forcing the diaphragm and stem 10 downward, closing the port leading to passage *e*, and stops the whistle blowing. Each reduction of signal line pressure should give one blast of the whistle. *New York:* A sectional view of the New York signal valve is given in Figure 70. A signal line connection is

NEW YORK SIGNAL VALVE
FIG. 70



made at X, and the pipe leading to the signal whistle is connected at Y. Air pressure from the signal pipe enters the valve through the small port *d*, and fills chamber A. The space around valve 10 is also a part of chamber A, above the rubber diaphragm 12. On each side of this diaphragm there is a metal disk; the one on the top being made of sheet iron and the one on the bottom of brass. Through these disks there is screwed a

brass plug having a small hole *c, c,* drilled throug it. From chamber A pressure slowly feeds dow through this small hole into chamber B, until th pressures in chambers A and B, on both sides o the rubber diaphragm, become equal. When th signal cord is pulled, causing a reduction of pres sure in chamber A above the diaphragm 12, an the pressure in chamber B forces the diaphrag 12 upward, which is connected with the valve 1 by three uprights *a, a,* (one upright is not show in the illustration), thus permitting pressure fro chamber A to flow into the passage *e,* leading t the signal whistle and causing it to blow, whil chamber B pressure passes slowly back throug *c, c.* (The reason the pressure reduces faste in chamber A than in chamber B is on account o the passage *c, c,* to chamber B being very small. When the discharge valve closes air from the mai reservoir restores the signal line pressure, whic is increased in chamber A faster than in chambe B, thus forcing the diaphragm and stem 10 dow ward, closing the port leading to passage *e,* an stops the whistle blowing.

CHAPTER XVII.

HIGH SPEED BRAKE (WESTINGHOUSE.)

A glance at the accompanying speed curve, Figure 71, will clearly show the advance of the air brake art, a condition that made it possible to run high speed trains with safety. The introduction of the high speed brake was necessary on account of the call of the traveling public for higher train speed, rendering it necessary to insure safety to lives and property. It was designed to stop fast trains within a reasonable and safe distance. It can also be used advantageously to save time in making service stops.

The higher pressure used causes prompt response of brakes due to the quicker action of air at high pressure. In other words the brake has more life in it, the same as an engine has when the boiler pressure is increased.

In using the high speed brake, the engineman should bear in mind that with a train-pipe pressure of 110 pounds, the usual piston travel, and a service train-pipe reduction of five, ten or fifteen pounds, no more cylinder pressure is developed than if the seventy-pound train-pipe pressure were employed. If, however, when using 110 pounds pressure, the reduction be continued after the cylinder pressure has reached that point at which

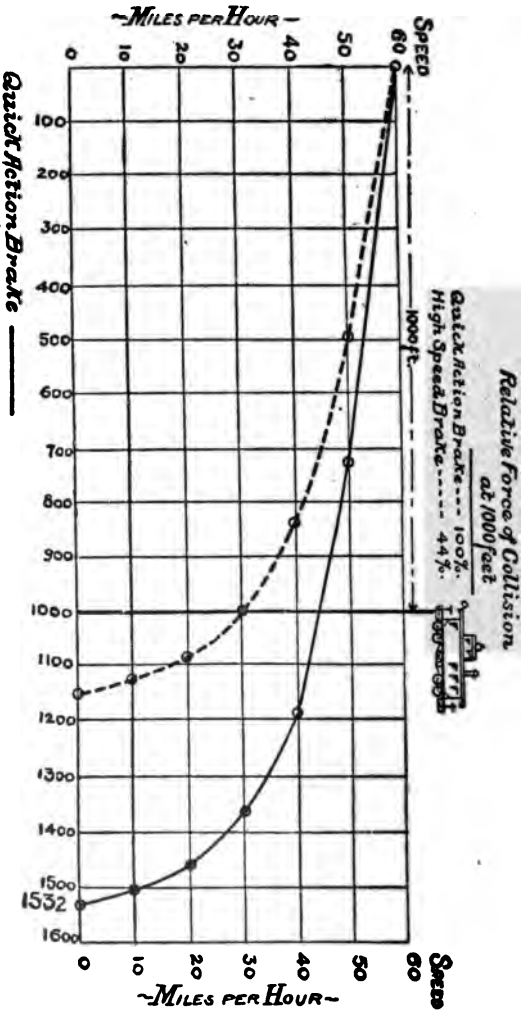

~Miles per Hour~
Speed
0
10
20
30
40
50
60
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1532
1600
1000 ft.
Relative Force of Collision at 1000 feet
Quick Action Brake---- 100%.
High Speed Brake----- 44%.
Quick Action Brake
High Speed Brake
~Speed Curves for Stopping~
~With Quick Action and High Speed Brakes~

FIG. 71

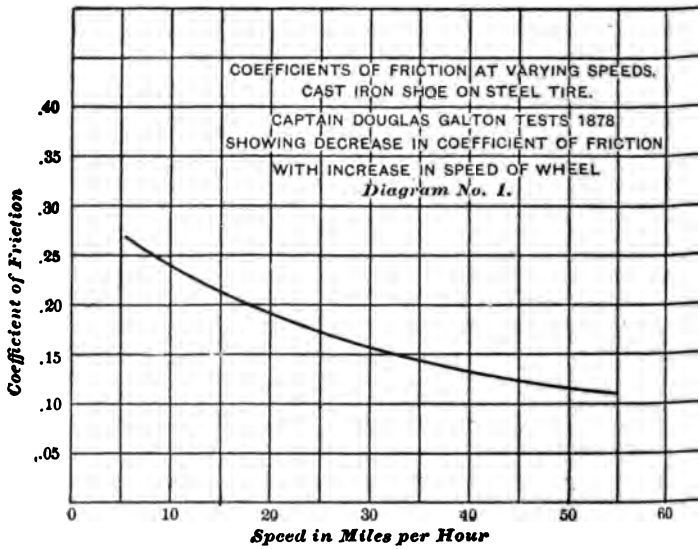
the auxiliary reservoir and brake cylinder equalize with the seventy-pound pressure the cylinder pressure will increase until the reducing valve operates.

At high speed, by using the emergency application when necessity requires it, the brake cylinder pressure is raised to about eighty-five pounds; immediately the reducing valve gradually blows down the brake cylinder pressure to sixty pounds as the speed of the train reduces, finally retaining at the latter part of the stop such pressure as is safe for slow speeds without sliding wheels. On account of this higher pressure with high speed quicker stops can be made, thus making it easier to accomplish schedule time.

The high speed brake was constructed so as to conform with the laws of friction at different speeds, of which elaborate tests have been made in England and in the United States. These tests substantiated the following facts: (1) That the friction exerted between the wheel and the rail is practically constant at all speeds; (2) that the friction exerted between the brake shoe and the wheel is very much less at high than at low speed. (see Figure 71-*a*); (3) that on account of this much less frictional resistance at high speed, a considerably greater pressure can be applied to the brake shoe when the speed is high, without danger of sliding the wheels; (4) that in order to make a brake shoe exert as great a retarding force at high as at low speeds, it must be subjected to a greater pressure at high speeds, which pressure

must diminish as the speed of the train decrease or the wheels will slide. The high speed brak arrangement is practically the quick action auto matic brake with a few pieces of extra apparatu added. To make the difference between the tw

FIG. 71a

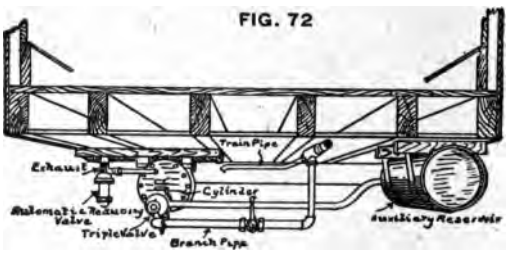


more clear it will be presumed that an ordinar quick action brake is about to be changed to high speed brake. Starting with the *passenger ca equipment,* all that is necessary is the addition o an *automatic reducing valve* (see plate F-45 an G-50, Appendix) connected by a pipe to the brak cylinder; the tender equipment has the additio of the automatic reducing valve as with the passe

ger car, and a quick action triple valve substituted for the plain triple. This also requires that the plain brake cylinder head be changed for the type used with the passenger car equipment. The most changes are made in the *engine* equipment, and consist of (1) the addition of an automatic reducing valve which is connected to the pipe leading from the triple valve to the brake cylinders, in this way one reducing valve can regulate the pressure in the driver and engine truck brake; (2) the substitution of a duplex governor for the single governor; (3) the addition of an extra feed valve which with the other feed valve forms a duplex feed valve connected to a special reversing cock. In order to make the pipe connection for this duplex feed valve, a feed valve pipe bracket is connected to the brake valve. The object of having two governors and two feed valves is so that the engine equipment can be changed at a moment's notice from a high speed brake to an ordinary quick action brake, or vice versa, by simply turning the cock in the governor air pipe and the cock between the two feed valves. It is understood, of course, that only one governor and one feed valve is operative at one time. Both governors are connected with, and are therefore operated by, main reservoir pressure. The one which has the cut out cock in the air pipe leading to it, is adjusted to stop the pump when 90 pounds pressure is obtained in the main reservoir, and the other one adjusted for about 120 pounds or over as necessity requires. Also one feed valve is ad-

justed for 70 pounds train-line pressure and others for about 110 pounds train-line pressu For low pressure brakes the cut out cock to 90 pound governor must be open, and the reve ing cock handle turned toward the feed valve justed for 70 pounds. Therefore, when it is sired to use the high speed brake the cock in pipe leading to the governor adjusted for pounds is closed and the reversing cock betwe

FIG. 72



—Passenger Car Equipped— —with— —High Speed Brake—

the two feed valves turned so as to cut in the hi pressure feed valve; thus a pressure of 110 pou in the train-line and 120 pounds in the main r ervoir will be obtained. The high speed brake operated in precisely the same manner as quick action brake, the success of it depend principally on the reducing valve. Figure 72 sh how the reducing valve is connected to the br cylinder.

The Automatic Reducing Valve. (Figures

and 74.)—When the air enters the brake cylinder from the auxiliary reservoir, it has free access to the reducing valve through a pipe connected at Z

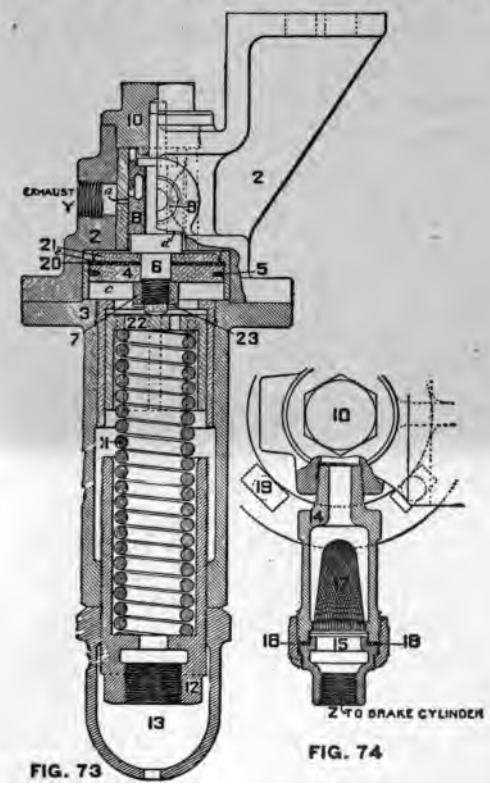


FIG. 73 FIG. 74

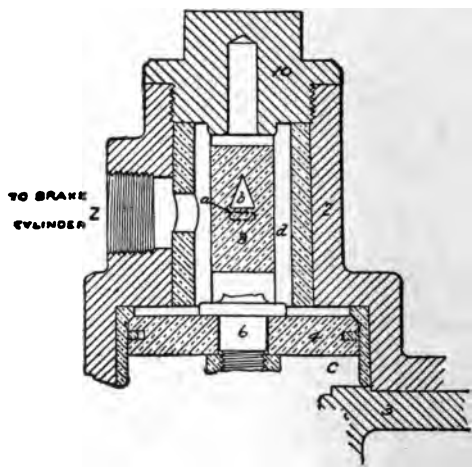
AUTOMATIC REDUCING VALVE.

(Figure 74) so that chamber *d*, above piston 4, is always subject to brake cylinder pressure. Regulating spring 11, adjusted by nut 12, provides a

resistance to the downward movement of piston 4, which is finally arrested by spring box 3. Combined with piston 4 is its stem 6, fitted with two collars which control the movements of slide valve 8. Slide valve 8 is provided with a triangular port *b* in its face, which is always in communication with chamber *d*. Port *a* in the slide-valve seat leads directly to the atmosphere through exhaust

POSITION OF PORTS.
RELEASE.

FIG. 75



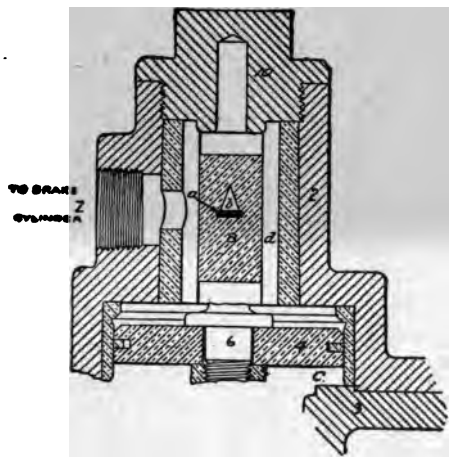
opening Y (Figure 73). In Figures 73 and 75 slide-valve 8 and its piston 4 are shown in their normal positions, occupied so long as brake cylinder pressure does not exceed 60 pounds. Leather washer 20 makes a joint on the bushing when in this position.

It will be noted that, in release position (Fig-

ures 73 and 75) port *b* of slide-valve 8 does not register with port *a* off its seat, so that, when the brakes are applied, the air pressure is retained in the brake cylinder and is released in the usual way through the triple valve, unless it become suffi-

POSITION OF PORTS.
SERVICE STOPS.
PRESSURE EXCEEDING 60 POUNDS
IN BRAKE CYLINDER

FIG. 76



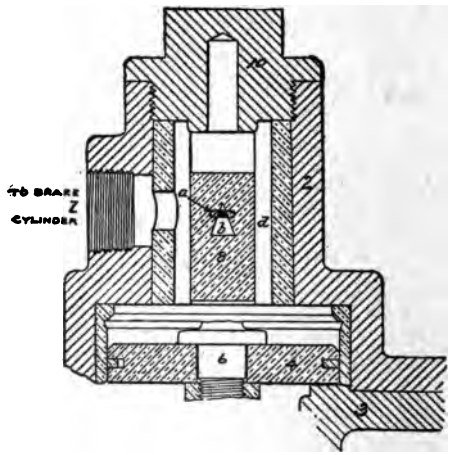
ciently great to overcome the tension of spring 11 and force piston 4 downward.

When the brake cylinder pressure begins to exceed 60 pounds in a heavy service application, the pressure upon piston 4 moves it downward until port *b* in the slide valve registers with port *a* in its seat, as shown on Figure 76, in which posi-

tion any surplus brake cylinder pressur promptly discharged to the atmosphere. Sp 11 then raises the piston and slide-valve to t normal positions (Figure 73), closing the exh port and retaining 60 pounds pressure in brake cylinder. In the operation just descri

POSITION OF PORTS. EMERGENCY STOP.

FIG. 77



the greatest width of port *b* is exposed to por and these ports are so proportioned that, in particular position the surplus air is dischar from the cylinder fully as rapidly as it is admi through the service application port of the tr valve.

The positions assumed by piston 4 and sl valve 8 in an emergency application of the bra

are shown in Figure 77. The violent admission of air into the brake cylinder then so suddenly increases the pressure that piston 4 is forced to the lower end of its entire stroke, in which position the apex of triangular port *b* in the slide-valve is brought into register with port *a*, and a comparatively slow discharge of brake cylinder pressure takes place while the train is at its highest speed; but the area of the opening of port *b* gradually increases as the reducing pressure above piston 4 permits spring 11 to slowly raise the piston and slide-valve. The rate of the discharge thus increases as the speed of the train decreases until, finally, when the brake cylinder pressure has become reduced to 60 pounds, port *a* is closed, as in Figure 75, and the remainder of the brake cylinder pressure is retained until released in the usual way through the triple valve.

When an emergency application of the brakes occurs at high speeds, there is little danger of wheel sliding, and it will be observed that port *b* is so shaped that brake cylinder pressure escapes slowly; while, at lower speeds, where a heavy service application is more likely to occur, and there is a greater tendency toward wheel sliding, the base of triangular port *b* is exposed, allowing brake cylinder pressure to reduce quickly.

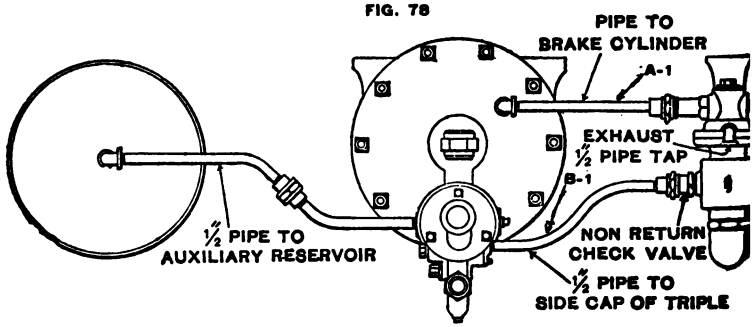
Cars not equipped with the automatic reducing valve should not be attached to trains employing the high speed brake, unless the brake cylinders are equipped with the safety valve provided for temporary use, in such cases. The safety valve

(illustrated on Plate 48, Figure 2, Appendix) has been especially designed to prevent a higher than standard pressure in the brake cylinders of cars not equipped with the automatic reducing valve; it may be quickly screwed into the oiling hole of the brake cylinder head, and removed when the cars are again placed in ordinary service.

Reducing valves are made with 3 sizes of ports. The one with smallest port is for 8 inch brake cylinder, the medium size port for 10 and 12 inch

NEW YORK COMPENSATING VALVE

FIG. 78



brake cylinder, the largest size port being for 14 and 16 inch brake cylinder. This arrangement is made so that the different sized cylinders will have their pressures reduced equally.

New York Compensating Valve for High Speed Brakes.—Illustrated herewith is a "compensating valve" designed to be used in high speed brake service.

Figure 78 is a view showing the pipe arrange-

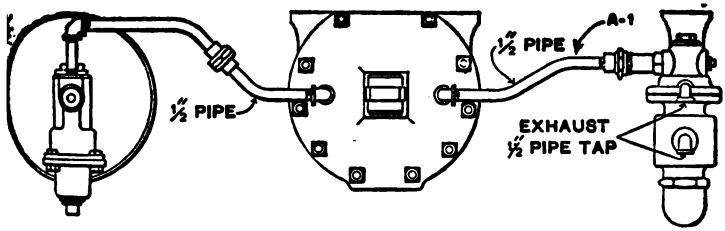
ment between the compensating valve and the quick action triple valve and brake cylinder. As will be seen, the connection to the triple valve is made in the side cap of the triple valve, the other end of the pipe connecting to the lower part of the compensating valve. The brake cylinder pipe is connected to the upper part of the compensating valve. Figure 79 is a view of the piping arrangement for plain triple valve.

Figure 80 is the top view of the compensating

NEW YORK COMPENSATING VALVE

PIPING DIAGRAM

FIG 79



valve, and shows the connections to the brake cylinder.

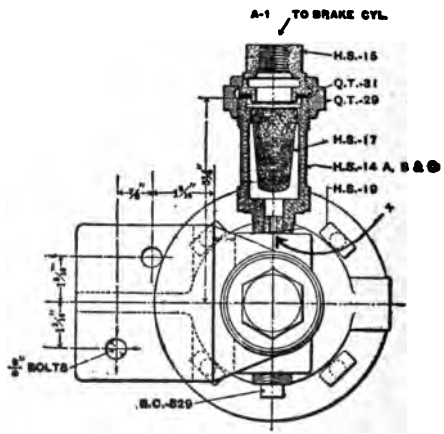
Figure 81 is a sectional view of the compensating valve. As will be seen, the valve may be conveniently divided into two separate portions, consisting of a lower portion and an upper portion. The upper portion consists of a piston, C, two packing rings, D, and a leather joint or seal on top of the piston. These parts operate in cham-

ber B, which contains brake cylinder pressure. When in normal position, the packing rings, D, of the piston, C, cover small ports *a* and *b*.

The lower portion of the valve consists of chamber A, regulating spring, F, non-return check valve, G, and its spring, K. Z is the point at

NEW YORK COMPENSATING VALVE

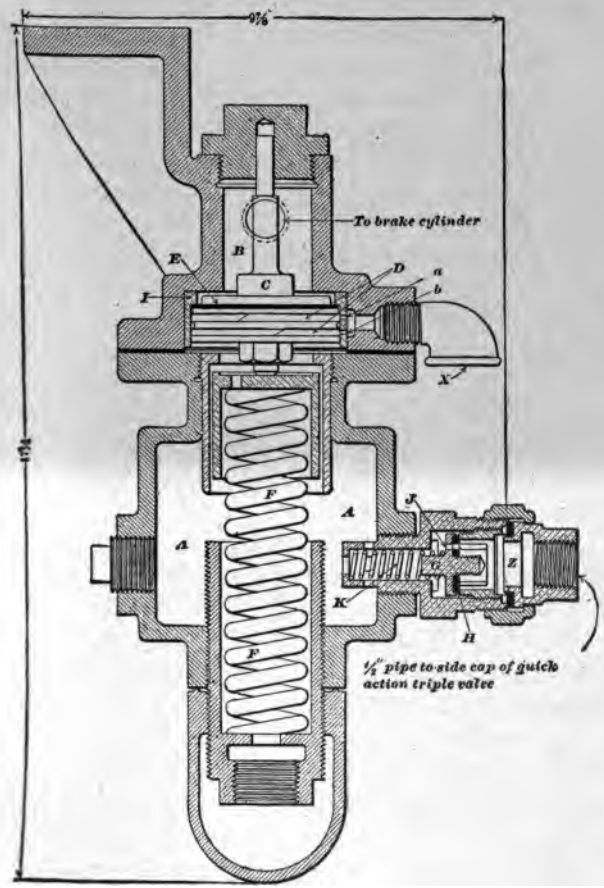
FIG. 80



which pressure enters the compensatory valve to occupy chamber A.

The operation of the valve is as follows: When an emergency application is made with the New York type of triple valve, train-pipe air is vented to the atmosphere. When the compensating valve is used, however, this air leaves the triple valve at the side cap connection of the triple, passes

NEW YORK COMPENSATING VALVE
FIG. 81



through the connecting pipe to Z, in the compen sating valve, lifts the non-return check valve (from its seat, and passes into and occupies cham ber A. The adjusting spring F, having been pre viously set to give a resistance of 60 pounds, com bined with the air pressure which has just entere chamber A, exerts an upward force on the pisto C, greater than the downward pressure of th brake cylinder air on the top of the piston.

The emergency application, which gives onl auxiliary-reservoir pressure in the brake cylinde with the New York brake, amounts to about 7 pounds, assuming that 110 pounds train-line pre sure is carried and piston travel is closely ad justed. Thus there is a downward pressure o piston C of about 78 pounds and a greater up ward pressure, consisting of the combined pre sure of the regulating spring and the air pressur in chamber A.

Immediately upon the entrance of air to cham ber A, this air leaks back through the small por J in the non-return check valve, to the side ca of the triple valve, thence to the atmosphere, thu slowly reducing the pressure in chamber A.

The capacities of chamber A and small port are so proportioned that a period of about fiv seconds is required for the pressure in chambe A to reduce itself sufficiently low to permit th brake cylinder pressure on top of the piston t be the greatest. Thus the greater pressure i chamber B will overcome the upward resistin pressure in chamber A, forcing piston C dow

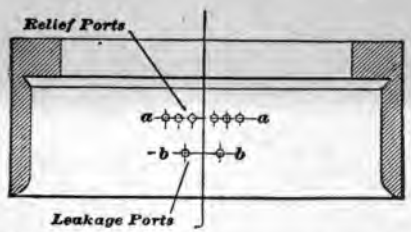
ward and uncovering ports *a*, through which the brake cylinder pressure will begin to reduce.

In this way the compensating valve is made to hold the maximum brake cylinder pressure unreduced for a period of several seconds, then the brake cylinder pressure is gradually reduced until the pressure on top of the piston in chamber B is less than the upward pressure of the adjusting spring, 60 pounds, and the piston C returns to its

NEW YORK COMPENSATING VALVE

PORTS IN THE BUSHING

FIG. 82



normal position, which is its uppermost limit, and is sealed against the leather joint E.

Figure 82 shows a section of the bushing I in which the piston C and packing rings D operate. The upper row of six small ports is the relief or reducing ports *a*, one of which is shown in Figure 81. The lower row, of two ports, *b* (Figure 81), are termed "leakage ports." However, inasmuch that said leakage would follow the same channel through which chamber A pressure escapes, ports

b would seem superfluous for this purpose. They would seem to operate to better advantage as additional relief ports in heavy service application.

In a service application the lower parts of the compensating valve do not operate. However, if the brake cylinder pressure reaches a point higher than 60 pounds, the resistance of the adjusting spring piston C will make a downward movement and permit cylinder pressure to escape to the atmosphere through the series of ports *a*, and possibly require the use of ports *b* also.

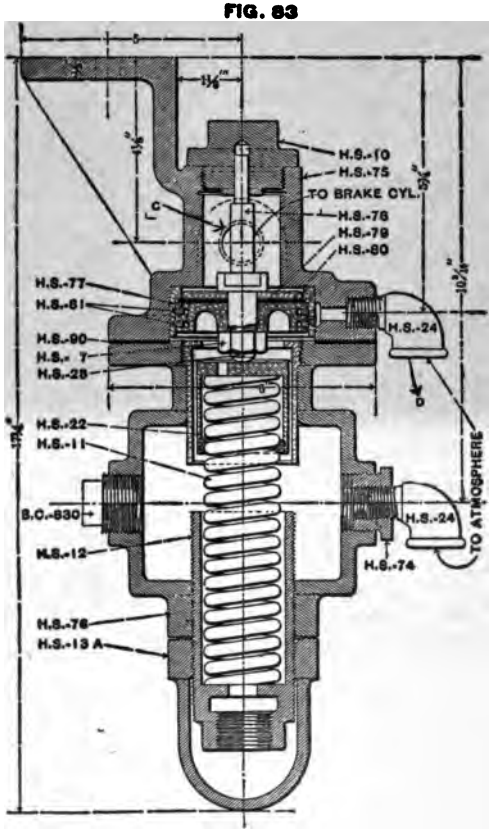
Figure 83 shows the compensating valve as used with a plain triple. Comparing this view with that of Figure 81, it will be noticed that the non-return check valve is not necessary with the plain triple, and that a reducer and street ell is used in its stead.

When the compensating valve is used with the plain, or any style triple, except the New York quick action, no train-pipe air is vented into the spring box chamber, and there is no air pressure in emergency applications added to the regulating spring pressure to delay the opening of the valve. The compensating valve will then operate like an ordinary safety valve except that in emergency applications about full equalized brake cylinder pressure will be had from an auxiliary-reservoir pressure of 110 pounds.

Ordinarily, safety valve, or pressure reducing valves, in emergency applications, while the pressure is going upward in the cylinder, open before

the maximum equalized pressure is obtained. This early opening tends to rob the cylinder of air, and

NEW YORK COMPENSATING VALVE
FIG. 83



) give a lower maximum brake cylinder pressure an would be obtainable if the valve did not open

until after the auxiliary and brake cylinders equalized.

By reference to Figure 80, it will be seen that the opening, X, through the union stud through which the air passes into the chamber above the piston, is considerably restricted so that in service applications it will provide sufficient opening for the surplus brake cylinder air to pass through to relieve the brake cylinder of overpressure, while in emergency applications the equalization between the auxiliary-reservoir and the brake cylinder being so quick the highest pressure obtainable in the brake cylinder will be had. This is because the increased volume of air cannot escape before about the full equalized pressure has been obtained in the brake cylinder. After the full equalized brake cylinder pressure has been obtained the valve will then relieve the cylinder in the ordinary way, blowing down to the point of adjustment.

The union stud H.S. 14 is made in three sizes, with passage X small, medium and large, for 8″, 10″, 12″, 14″ and 16″ cylinders respectively. This gives a more uniform blow down of brake cylinder pressure for the different sized cylinders.

CHAPTER XVIII.

COMBINED AUTOMATIC AND STRAIGHT AIR ENGINE AND TENDER BRAKE.

All who have been in touch with switching and road work are familiar with the complaints about the inadequacy of automatic brakes for switch engines, and the frequent use of the reverse lever on engines so equipped; also the many schemes and devices employed to apply or at least hold the engine brake applied when the automatic brake is released and the decided preference expressed by engineers for *straight air* or *steam brakes* on the drivers and tender of switching or freight locomotives. This led to the adoption of the *combined automatic* and *straight air brake.*

Its Use.—(1) To quicken switching. (2) To permit the brakes of long trains to be released without danger of the slack running out suddenly and train breaking in two. (3) To prevent change of grade (sags, lumps or curves) from running slack in or out too rapidly. (4) To slow trains up where brake work required is light. (5) To aid pressure retaining valves on cars in controlling the speed of train while recharging on heavy grades. (6) to hold the train or locomotive and keep the automatic brakes recharged when standing on grades. (7) To control speed while weighing cars.

(8) to decrease the repairs and improve the service of the automatic brakes.

Additional Parts.—One straight air brake valve one straight air reducing valve; two double check valves; two safety valves; additional piping and special air hose between tender and engine; grad cocks for heavy grade service.

General Arrangement.—Figure 84 illustrates the general arrangement of the Westinghouse apparatus. Connection is made at three points with the automatic brake. The straight air supply is taken from the main reservoir pipe near the automatic brake valve. Before reaching the *straight air brake valve* the air must pass through the *reducing valve* set at 45 pounds, to prevent more than that amount entering the brake cylinders.

The two double check valves are inserted on the tender and engine in the pipe leading from the triple valve to the brake cylinder or cylinders so that in automatic brake operation auxiliary air will have to pass through this double check valve in getting to or from the brake cylinder.

The pipe leading from the straight air brake valve has two branches, each entering one of the double check valves at the end opposite the triple valve connection, so that in application and release the straight air pressure will also have to flow through the double check valves.

The two side springs of the double check valve are brake cylinder connections. They are joined by a cored passage way.

Safety Valve.—If convenient the safety valve

GENERAL ARRANGEMENT OF THE WESTINGHOUSE COMBINED APPARATUS

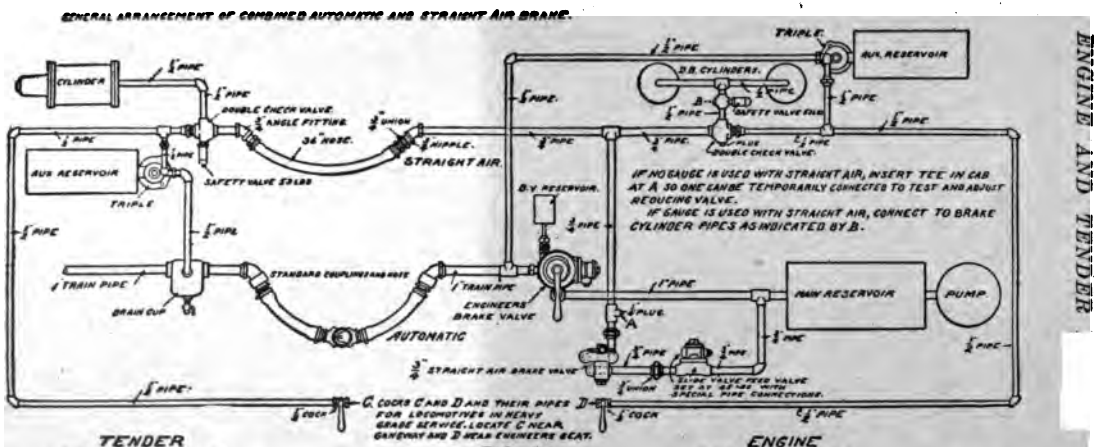

GENERAL ARRANGEMENT OF COMBINED AUTOMATIC AND STRAIGHT AIR BRAKE.
CYLINDER
DOUBLE CHECK VALVE.
ANGLE FITTING.
34" HOSE.
STRAIGHT AIR.
AUX. RESERVOIR
TRIPLE
SAFETY VALVE 50 LBS
TRAIN PIPE
DRAIN CUP
STANDARD COUPLING AND HOSE
AUTOMATIC
B.V. RESERVOIR.
ENGINEERS BRAKE VALVE
STRAIGHT AIR BRAKE VALVE
C. COCKS C AND D AND THEIR PIPES FOR LOCOMOTIVES IN HEAVY GRADE SERVICE. LOCATE C NEAR GANGWAY AND D NEAR ENGINEERS SEAT.
TRIPLE
AUX. RESERVOIR
D.B. CYLINDERS.
SAFETY VALVE 50 LBS
DOUBLE CHECK VALVE.
IF NO GAUGE IS USED WITH STRAIGHT AIR, INSERT TEE IN CAB AT A. 30 ONE CAN BE TEMPORARILY CONNECTED TO TEST AND ADJUST REDUCING VALVE.
IF GAUGE IS USED WITH STRAIGHT AIR, CONNECT TO BRAKE CYLINDER PIPES AS INDICATED BY B.
MAIN RESERVOIR
PUMP
TENDER
SCHEDULE S-W-B
ENGINE
SCHEDULE S-W-A

FIG. 84

may be screwed into one opening on the tender brake, as shown, or with the driver brake one brake cylinder may be connected to each and the safety valve in either driver brake cylinder pipe. Each safety valve should be adjusted to open at 53 pounds. The safety valve is the same kind as used with the high-speed brake, Figure 2, Plate F-48. Appendix.

The Grade Cocks C and *D*, with their pipes, are for locomotives on grades. These cocks are located so that in descending heavy grades they can be quickly opened and left so. The driver and tender auxiliaries are recharged with those of the train but automatic action is prevented on the driver and tender brake, thus permitting the greatest practical use of the *straight air* without danger of loosening tires of the drivers and tender while recharging the train-brakes. *A* and *B* indicate gauge connections. A gauge for straight air is desirable. When employed it should be connected so as to show brake cylinder pressure in *automatic* as well as *straight air* application, such connection being indicated by B. With no permanent gauge a tee is connected as indicated by *A* for the purpose of testing and adjusting.

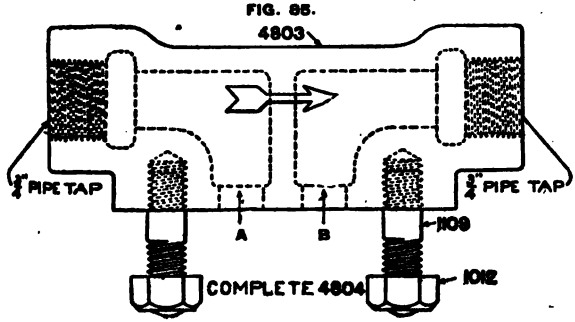
Figure 85 illustrates the *special feed valve pipe bracket* to which the *slide-valve feed valve,* acting as a *reducing valve* for the *straight air,* is connected, inlet port *A* and outlet port *B* coming opposite the ports in the feed valve. The arrow lays across the dividing wall.

Figure 86 illustrates the *special straight air hose*

connection between the engine and tender. The union end being forward permits the use of a blind gasket in case of a burst hose or bad-order tender brake. Figure 87 illustrates the *double check*

FEED VALVE PIPE BRACKET

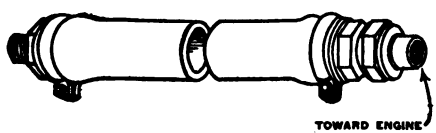
FIG. 85.



valve in section, the several connections being there indicated. (The combined brake depends upon the double check valve.) Between the two seats *a* and *b* is a piston valve 4 having a leather

36-INCH HOSE FOR STRAIGHT-AIR TENDER CONNECTION

FIG. 86



face 6 on each end. The piston valve is shorter than the distance between the two seats, and the bush in which it works has two series of ports, *C* and *C'*. With the piston against the seat *b*, as shown, port *C* affords a free passage for air be-

tween the straight air brake valve and brake cy inder. The opening to the triple is closed so n leakage can occur through the triple exhaust. Now with the straight air brake valve in release posi tion (where it should be when not in use), assum that the automatic brake is applied; the air fron the triple on entering the double check valve wil

DOUBLE CHECK VALVE

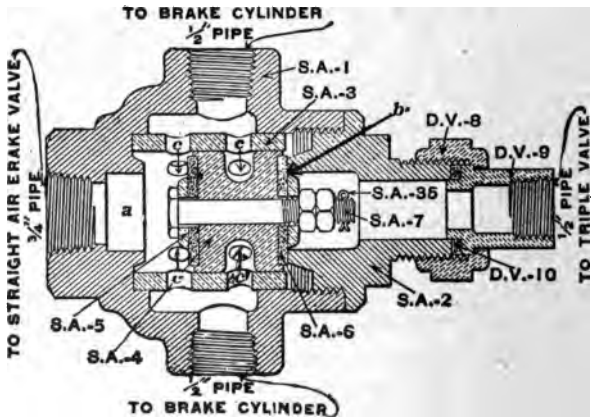


FIG. 87

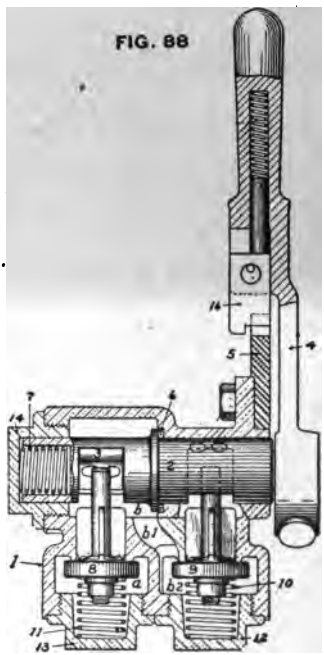
force the piston valve to the left against seat *a* thus preventing any escape at the straight air brake valve, and opening port *C'* so the auxiliary air can flow into the brake cylinder, returning the same way in release.

The double check valve must be in a horizonta position so its piston valve will not be moved ex cept by air pressure. Then the act of using eithe

omatic or straight air will cause its piston ve to automatically move to its proper position.

traight Air Brake Valve; Location.—This ve should be secured and so located that it can asily operated by the engineer when looking vard or back out of the cab window. Where the permits, the best location is against the side he cab at a convenient height and a trifle ford of the edge of side window ch opens.

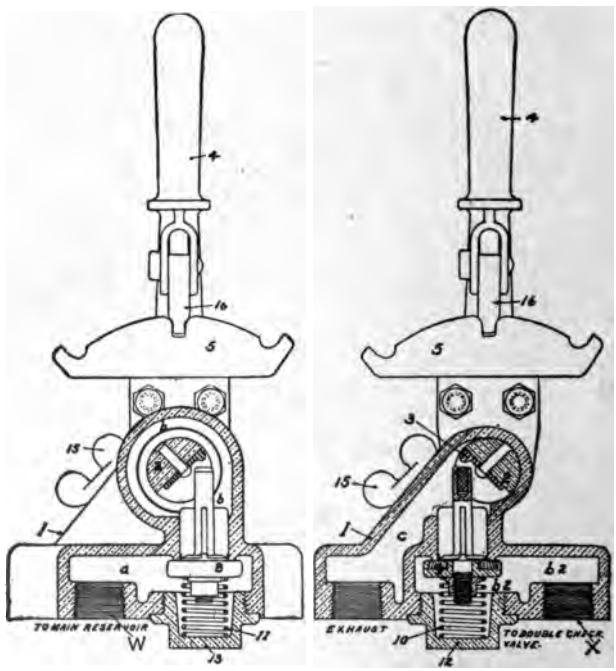
onstruction. — ures 88, 89 and illustrate the *estinghouse* ight air brake ve. Letters are t on the body to icate its main ervoir, brake e and exhaust nings. The aust opening uld have only a et ell to turn exhaust in any red direction, sound aiding engineer in ration. The r two connections should have unions near brake valve to facilitate exchange.



WESTINGHOUSE STRAIGHT-AIR BRAKE VALVE

Figure 88 is a sectional view parallel with th shaft 2, operated by the handle 4, which opens th application valve 8 or release valve 9. As indicate by *b*, *b1*, *b2*, the space above admission valve

FIG. 89 FIG. 90



WESTINGHOUSE STRAIGHT-AIR BRAKE VALVE

is connected with the one below exhaust valve 9 The leather gasket 6 makes the joint at the shaf collar.

Figure 89 is a section across the shaft at appli

cation valve 8 showing the connection *W*, by which main reservoir pressure, reduced to 45 pounds, reaches the lower side of valve 8 through cavity *a*. Figure 90 is a similar section across the shaft at exhaust valve 9, showing the cavity *b*2 below this valve. The brake pipe connection at X leads to the *double check valves*, and through them to the brake cylinders; also passageway *C* leading from the exhaust valve 9 out through the exhaust opening to the atmosphere. Shaft 2 is slotted out to the middle on nearly opposite sides, and valves 8 and 9 are just enough off the shaft center line so that the stem of each valve will end just beneath the flanged portion of the steel tappet piece riveted to each of the shaft slots. As shown by the section of valve 9 (Figure 90), these have steel caps to reduce wear; they are also fitted with leather seats.

In the three views the handle 4 is on lap position, valves 8 and 9 are held to their seats by their springs and any air pressure below them.

Moving the handle 4 to the right in Figures 89 and 90 unseats application valve 8 and allows main reservoir air to flow by it from cavity *a*, pass through *b*, *b*1 and *b*2, which brings it under release valve 9 and in communication with the pipe at X, by which it is carried to the double check valves and through them to the cylinders, applying the brakes. Moving handle 4 to the left will permit valve 8 to reseat and valve 9 to open, which will release the brake, the air from the cyl-

NEW YORK COMBINED STRAIGHT-AIR AUTOMATIC BRAKE
PIPING DIAGRAM

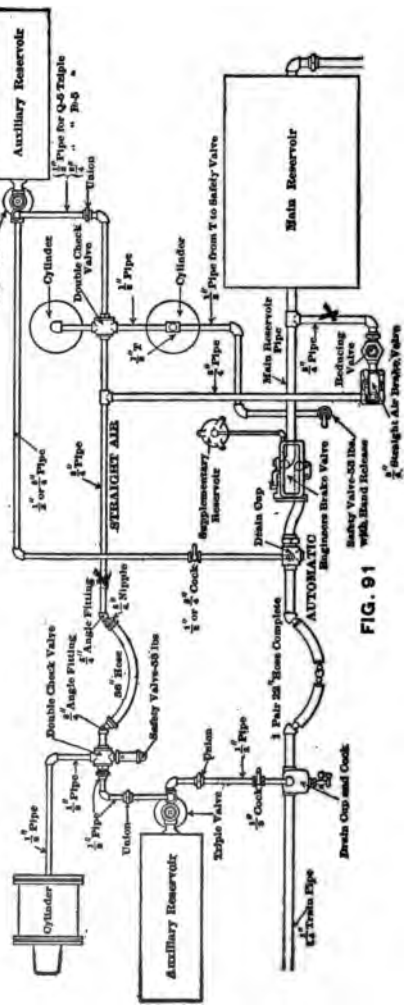


FIG. 91

nders passing out through chamber *C* to the tmosphere.

New York Combined Straight Air Automatic Brake.—The New York Combined Straight Air Automatic Brake, Figure 91, has practically the ame general arrangement and action as the Westghouse, with the following alterations: A special ized reducing valve that replaces the slide-valve eed valve and bracket; a special straight air rake valve; also a special safety valve with a ever attachment, which serves the double purpose f preventing too high a pressure and, when loated near the cab, serves the purpose of the 'grade cocks" or "hand release."

New York Reducing Valve (Figure 92).—This s practically an inverted old-style feed valve ttachment with slight alterations. A glance at t will show the absence of the special feed valve racket, but has direct pipe connections made to he reducing valve. It should always be located vith the spring casing on top, as shown, to pre-ent the deposit of water, oil or dirt on the diaphragm. The principle of this valve is explained nder the head of *Feed Valve Attachment*, and is djusted to close at 45 pounds.

New York Straight Air Brake Valve (Figure 3).—This brake valve serves the same purpose s the Westinghouse, although its construction is uite different. It has two main body parts pulled ghtly together by bolts, making a joint on gasket 30. A slide-valve 227, which is plainly shown moving on a flat seat (Views M and N). The

,main reservoir air reduced to 45 pounds is
pass through connection *W* to chamber *A*
of the slide-valve. The handle 222 is attac
the slide-va
a shaft 224,
has a forked
end engagin
pin on the b
the slide-
When the
moves forwa
slide-valve
back, or vice
View M illus
the valve on
lease posi
When it i
sired to app
straight air
handle is
back to the

NEW YORK STRAIGHT-AIR REDUCING VALVE

FIG. 92

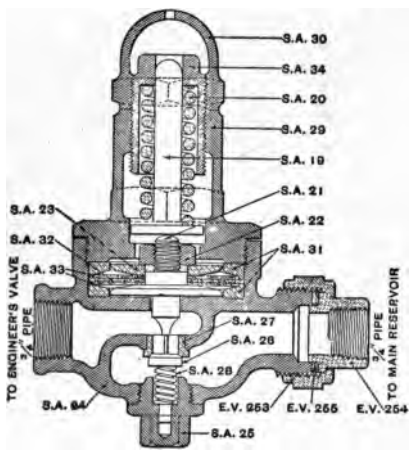
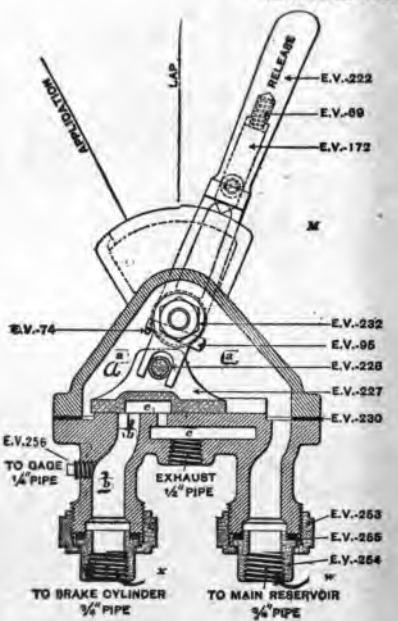
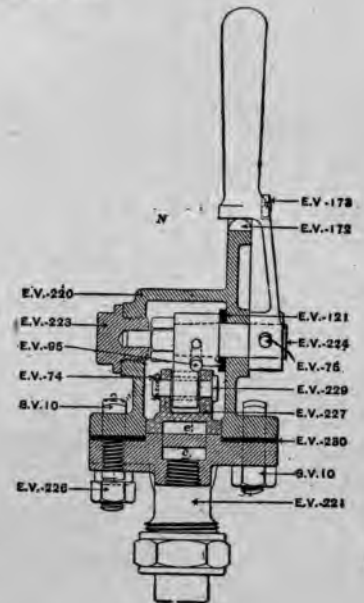


Figure 93, the slide-valve opens port *b* and main reservoir air in chamber *a* to flow through pipe connection X to the double valves and through them to the cylinders ing the brake. Moving the handle forward the admission from chamber *a*, while the e: cavity *e* connects port *b* with the exhaust, will release the brake, the air from the cyl passing out through chamber *C* to the atmos

New York Safety Valve (Figure 94).

NEW YORK STRAIGHT AIR BRAKE VALVE
FIG. 93

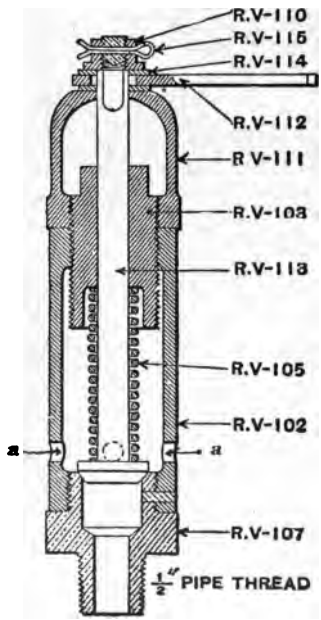




valve is constructed on practically the sam
as the Westinghouse safety valve, but has th
tional part called
lease handle. This
is piped to the
the engine in con
reach of the engi
shown in Figure
ranged in this ma
serves the purp
grade cocks as
being a safety
The lever handle
attached loosely
extended stem
valve 113; the n
and washer 11
screwed down to
contact, but do
terfere with the
ing spring 105, w
set at 53 pounds.
time the brake c
pressure is accum
greater than 53 pounds the valve 113 is
off its seat, the surplus air passing out t
ports *a*. In case the drivers slide or grad
is such that the driving tires are liable to b
ened the "lever handle" may be used to l
valve 113, thus permitting all or part of the
cylinder air to escape.

NEW YORK SAFETY VALVE

FIG. 94



From the foregoing description it will be

that all the features of the automatic brake are retained, enabling the driver and tender brakes to be operated with the train brakes by the automatic brake valve, yet the straight air attachments give the engineer the long-sought independent driver and tender brake, which fulfills a requirement described in the paragraph headed "*Its Use*" in this chapter.

CHAPTER XIX.

CALCULATIONS FOR EQUALIZING AIR PRESSURES.

Area of a Piston.—Multiply the diameter of the cylinder by itself and the product by the decimal .7854. Suppose we consider the 8-inch freight brake equipment; 8×8=64. Multiply by .7854= 50.26 square inches.

Volume of a Cylinder.—Multiply the area by the piston travel; add the clearance between the piston and the cylinder head, which is about ⅝ of an inch, and the volume of the pipe between the cylinder and triple valve; also the space in the triple occupied by brake cylinder air. Consider an 8-inch travel; 50.26×8=402 cubic inches. Adding the clearance, which is about 48 cubic inches, makes a total of 450 cubic inches cylinder volume.

Volume of Air Reservoir.—Obtain the inside diameter, which is usually ½ inch less than the outside measurement. Use the method for obtaining the "*area of piston,*" then multiply the product by the inside length of the reservoir, the result being the cubical contents. This method is not exact, as the dimensions are not easily obtained. By the use of water as a substitute for air (at 60 degrees, 62½ pounds of water filling one cubic foot) it has been found that the auxiliary reservoirs have volumes as follows:

Cast iron reservoir for 8-inch freight brake contains about 1,620 cubic inches.

10x24	wrought	iron	reservoir	1,510	cubic inches.
12x33	"	"	"	3,080	" "
14x33	"	"	"	4,120	" "
16x33	"	"	"	5,322	" "
16x42	"	"	"	7,075	" "
10x12	Equalizing		reservoir	620	" "
10x14½	"		"	850	" "

Sizes of main reservoirs are governed by the location on the locomotive on which they are to be used.

Volume of Freight Train-Pipe.—The ordinary 34-foot freight car has 640 cubic inches of train-pipe volume; this includes all space in hose, pipe and part of the triple valve. This volume varies with the lengths of cars.

Equalization of Air Under Pressure.—It should be remembered that it is *air* that flows from one part of the equipment to the other—not *pressure.* Pressure is the condition of the air. If air flows from the main reservoir to the train-pipe, or from the auxiliary to the brake cylinder, it will change the pressure.

Calculations for Equalizations.—If it is desired to calculate at what pressure two volumes of air at unequal pressure will equalize when allowed to flow from one to the other, it will be necessary to change the volumes and pressures to one quantity for comparison. This quantity is cubic-inch-pounds, to which all volumes and pressures can be converted by multiplying the volume in cubic inches by the number of pounds pressure. *Exam-*

ple: A standard freight auxiliary contains 1,620 cubic inches; with a gauge pressure of 70 pounds the result would be 1,620×70, or 113,400 cubic inch-pounds. A gauge shows the pressure above the "atmospheric" line. "Absolute" pressure begins at the "vacuum" line. If it is desired to compute absolute pressure always add fifteen pounds to the gauge pressure before starting the calculation and subtract the fifteen pounds from the result to get back to the gauge pressure again. If the equalization takes place between pressures above the atmospheric line, this fifteen pounds need not be added. Where piston travel is considered, the vacuum must be filled as the piston moves out; therefore the fifteen pounds should be considered.

Equalization of Main Reservoir and Train-Pipe. —A main reservoir of 20,000 cubic inches capacity is charged to 100 pounds. At what pressure will it equalize with an empty train-pipe of twenty-five freight cars? Multiply the volume of the main reservoir by its pressure, dividing the product by the combined volume of the main reservoir and train-pipe.

20,000×100=2,000,000 cubic-inch-pounds.

640×25=16,000, volume of train-pipe.

20,000+16,000=36,000, combined volume of both.

2,000,000÷36,000=55½, or the pressure at equalization.

Suppose the same train-pipe was charged to 35 pounds, the same reservoir charged to 100 pounds as before; at what will they equalize?

16,000×35=560,000+2,000,000=2,560,000 cubic-inch-pounds.

2,560,000÷36,000=71, the equalized pressure.

Equalization of Auxiliary and Brake Cylinder.—In figuring this let us take an 8-inch freight cylinder at 8-inch travel, the auxiliary having a volume of 1,620 cubic inches and charged to 70 pounds. In this problem figure from the vacuum line; 70+15=85, absolute pressure; 1,620×85=137,700, cubic-inch-pounds in auxiliary.

We will also consider the air in the clearance of the cylinder, which has 15 pounds atmospheric pressure:

48×15=720, cubic-inch-pounds.

137,700+720=138,720, total cubic-inch-pounds.

1,620+450=2,070, total cubic inch contents for equalization.

138,720÷2,070=66.8; subtracting 15 we have 51.8 pounds gauge pressure in brake cylinder.

Emergency Application.—How much brake cylinder air comes from the train-pipe during emergency application with the Westinghouse quick-action triple valve, the brake having been charged to 70 pressure and equalizing at 60 pounds after brake application is completed?

60+15=75, the number of pounds absolute pressure.

450×75=33,750, cubic-inch-pounds.

The auxiliary furnished only 10 pounds during the action, which is 10×1,620, or 16,200 cubic-inch-pounds.

33,750—16,200=17,550 cubic-inch-pounds which came from the train-pipe.

17,550÷450=39, pounds absolute pressure; 39—15=24, the amount of air supply by the train-pipe to the brake cylinder.

Equalization with Retainer in Use.—The retainer holds 15 pounds in the brake cylinder while the auxiliary is recharged to 70 pounds; at what will they equalize when the brake is again applied?

450×15=6,750, cubic-inch-pounds held by retainer.

70×1,620=113,400, cubic-inch-pounds in auxiliary.

6,750+113,400=120,150, total cubic-inch-pounds in both.

450+1,620=2,070, total cubic inch volume.

120,150÷2,070=58, the number of pounds pressure after equalizing.

Partial Application.—What brake cylinder pressure will result from a partial application? Suppose the reduction be 10 pounds. This reduction represents 10×1,620 cubic-inch-pounds to pass to the brake cylinder. Allowing for the atmospheric air in the clearance space of 48 cubic inches we have 48×15, or 720 cubic-inch-pounds.

16,200+720=16,920, total cubic-inch-pounds.

16,920÷450=37.6, the number of pounds absolute pressure.

37.6—15=22.6, the gauge pressure in the cylinder.

A ten-pound reduction from any given pressure

will give the same result, so long as it does not equalize the auxiliary and brake cylinder pressure.

After the first the succeeding reductions show a more rapid increase of gauge pressure, owing to the fact, as described above, that the first reduction fills the vacuum behind the moving piston, the next reduction building up brake cylinder pressure faster because of the vacuum being filled.

Tests do not always show the exact amounts as described above, owing to the fact that some air is wasted while the piston covers the leakage groove, auxiliary-reservoirs and cylinder clearance, vary slightly; the expansion of the air also lowers the temperature and consequently the pressure. The fall of temperature has not been considered in these calculations as the temperature of the air in the equipment under a car is practically equal to the surrounding atmosphere.

NOTE:—Descriptions of and instructions for manipulation of the Westinghouse "ET" Engine and Tender Brake Equipment and the New York Locomotive Brake Equipment, Style B3, will be found in the Appendix hereto.

CHAPTER XX.

APPLIANCES FOR AIDING IN THE HANDLING OF FREIGHT TRAINS ON GRADES.

In this chapter will be given a description of the construction, action and methods of operating special devices and appliances for aiding in the handling of freight trains on long and heavy grades. On medium grades the ordinary quick action brake has given very efficient service with both passenger and freight trains, but it is very difficult and quite dangerous to attempt the control of heavy trains on long and steep grades by means of the quick-action brake alone with 70 pounds pressure. The following table illustrates the different relative conditions, the figures being based upon a braking power of 70 per cent. of the light weight of an ordinary 60,000-pound freight car when a 70-pound train-pipe pressure is employed. In an emergency application of the brakes the brake cylinder pressure is, of course, 60 pounds, while in a service application the cylinder pressure is 50 pounds.

Kind of Application.	Empty or Loaded.	Braking power in per cent. of total weight.
Emergency	Empty	70
Emergency	Loaded	22.1 to 23.8
Service	Empty	58.3
Service	Loaded	18.4 to 20

This table shows that the braking power is so mall a proportion of the weight when a car is aded to its full capacity that even with a train- ipe pressure of 90 pounds there is ordinarily o danger of sliding wheels.

Both the Westinghouse and New York Air rake Companies have invented simple attach- ents to the ordinary quick-action brake which ave proved very satisfactory for aiding in the ontrol of heavy trains on grades. They consist f providing a means of increasing the pressure hen necessary, yet allowing the train to be han- led at other times with ordinary pressures; also roviding a high main reservoir with which the uxiliaries can be charged more quickly when nec- ssary. The attachments require no change being ade on the car equipments. All the changes nec- ssary were made in the engine equipment.

High Pressure Control or Schedule U.—This Vestinghouse special brake apparatus and its rrangement for the engine and tender is clearly hown in Plate 49, Appendix. It will be seen to iffer from the common equipment in that (1) the rdinary pump governor is replaced by a double r duplex governor; (2) the feed valve by a dou- le or duplex feed valve; (3) a safety valve is ttached to the tender brake cylinder, also one to ie pipe leading from the engine triple to the rake cylinder on the engine; in this way one ifety valve on the engine does service for the ree brake cylinders.

The duplex feed valve and pump governor are

exactly the same as used in connection wit
high-speed brake, but are piped differently,
comparison with the high-speed brake equi
(Plate G-50, Appendix) will show. In the
speed brake it will be seen both governor a
pipes are connected directly with main res
pressure, while in plate G-49 only the one ad
for 110 pounds is connected there; the one ad
for 90 pounds being piped to a connection
reversing cock (See Figure 1, Plate F-48, A
dix) of the duplex feed valve, which leads
chamber that communicates with the passag
the feed valve.

The description of the High-Speed Brake E
ment upon the locomotive applies also to t
the locomotive equipment with the High-Pr
Control Apparatus, except the effect produc
the change in the governor piping, which
follows: The reversing cock handle being
position shown in the diagram, causing t
pound feed valve and the 90-pound pump
ernor to be operative, the entire brake app
will operate in the usual manner, except und
condition. Where the pump governor is pi
the chamber in the feed valve bracket, as
case when Schedule U is used, main res
pressure is cut off from action upon the diap
of the pump governor when the brake valv
dle is in the Lap, Service Application or
gency Application position. It thus occurs
although the main reservoir pressure is op
upon the 90-pound pump governor diaphra

the Running Position of the brake valve, it is inoperative when the brakes have been applied and the valve handle has been returned to "lap" and main reservoir pressure may then be pumped up to the limit established by the high-pressure governor diaphragm, usually 120 pounds. This high main reservoir pressure insures a prompt release and quick recharging of the brakes upon a long train, and the pump has to operate against the high pressure only during the time that the brakes are applied.

To Operate Descending Grades.—Whenever loaded trains are to descend long, heavy grades, the handle of the reversing cock is turned to its opposite position, thus cutting out the 90-pound governor and the low-pressure feed valve. The train-pipe pressure is then controlled by the 90-pound feed valve, while the main reservoir pressure is under the control of the high-pressure governor only. The brakes are then operated in the usual manner; but, as the train-pipe and auxiliary-reservoir pressures are now 90 pounds, a much more powerful brake application is available if desired.

The purpose of the safety valves connected with the driver and tender brake cylinders is to prevent the accumulation of a higher cylinder pressure than 50 pounds.

When carrying a train-pipe pressure of 90 pounds upon freight trains a train-pipe reduction of about 25 pounds will be necessary to equalize

auxiliary-reservoir and brake cylinder pressures, with the customary average piston travel.

This equipment is particularly adapted for use upon heavy grades where "empties" are hauled up the grades and "loads" down, a pressure of 70 pounds being carried in the train-pipe when the cars are empty, but increased to 90 pounds when the cars are loaded. If the high pressure were carried with empty cars in the train flat wheels would be apt to result; but when the cars are loaded the higher braking power is so moderate a proportion of the total weight of the car and its contents that danger of wheel sliding is practically eliminated.

New York High-Pressure Control.—Although the results obtained by the Westinghouse high-pressure grade control apparatus, as explained under the preceding head, are obtainable with the New York brake equipment, the latter has two distinct arrangements of the air pipes leading to the governors to accomplish the results. The additions to the ordinary equipments are about the same as with the Westinghouse with the absence of the duplex feed valve.

First Arrangement.—The *"duplex governor."* This is the same as the Westinghouse high-speed brake, except that the air pipe leading to the duplex governor is connected to train-line pressure instead of main reservoir. When used in this way, however, both tops are connected to chamber E, Figure 35, in front of the feed valve, a tee for dividing the pipe being put at a convenient point,

nd a stopcock placed between the tee and the ow-pressure top so that the latter can be cut out when it is desired to carry a higher train-line pressure. The feed valve 97, Figure 97, maintains the excess pressure.

To Operate Descending Grades.—Close the cock in the air pipe leading to the governor set for 90 pounds. This will allow the pump to work until main reservoir pressure reaches 110 pounds, the amount at which the other governor is adjusted. This allows a constant pressure of 90 pounds train-line and 110 main reservoir. The brakes are then operated in exactly the same manner as before.

Second Arrangement.—The *"triplex governor"* is recommended either for freight service in mountainous sections or for high-speed passenger service. The "triplex governor" is composed of one governor steam valve and piston body, to which a triple (instead of a siamese fitting) is attached. Each arm of the triple fitting has a governor top inserted. In piping up this governor one top should be connected direct to the train pipe above the cut-out cock, usually to a tee inserted in the gauge pipe, and the top adjusted for the high train-pipe pressure. In this pipe a second tee should be placed, and connection made to another top. As this top is adjusted for the low train-pipe pressure, a cock must be inserted between it and this tee, so that this top can be cut out when higher train-line pressure is desired. The third top should be connected direct to the main reservoir, either to a tee in the gauge pipe or to a convenient point

in the main reservoir as far as possible from the air pump discharge pipe. The governor connection to chamber E forward of the feed valve must be plugged.

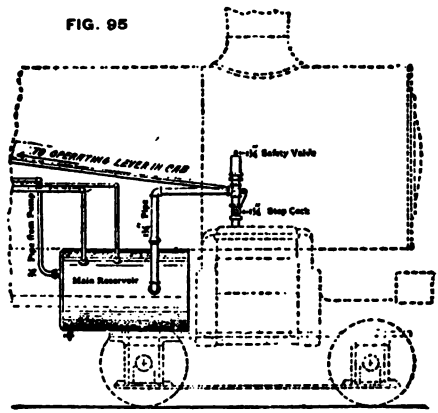
To Operate on Descending Grade or High-Speed Brake.—Closing the cock in the air pipe leading to the 70-pound governor allows the other train-pipe governor to operate, thus permitting of the high pressure for "grade work" or "high-speed brake." With this arrangement the third or main reservoir governor allows a high main reservoir pressure for releasing and recharging. This main reservoir governor operates while the brake valve is on "Lap," "Service" or "Emergency" positions when the train-pipe pressure is below the maximum, usually during brake application.

Sweeney Air Compressor.—Is an air compressing device that is used quite extensively where there are heavy, long grades. It is intended to act as an auxiliary to the air pump, although in case the pump becomes disabled it can easily supply the requisite amount of air necessary to handle the train down a steep grade.

Construction.—By reference to Figure 95 a fair conception can be formed of the construction and operation of the Sweeney air compressor, which is simple in the extreme. An inch and a quarter pipe is tapped into the top of the steam chest and connected to the main reservoir. A stop-cock operated by a rod reaching to a lever in the engine cab provides the means for the engineer to open and close at will. A check valve (not shown) is also

placed in the pipe close to the main reservoir in or der to prevent pressure from the latter flowing back

FIG. 95



THE SWEENEY AIR COMPRESSOR.

through the pipe into the steam chest. The safety valve is to prevent the main reservoir from being overcharged in case the engineer allows the compressor to continue working after the maximum amount of pressure is attained.

To Operate.—The conditions under which the Sweeney Compressor can be operated are: (1) the engine throttle must be closed, and (2) the engine running. It is put into operation by pushing the operating lever forward. Before cutting into service open the cylinder cocks and reverse the engine, bringing the lever several notches back of the center, provided the engine is running forward; then cut the compressor into service, close the cylinder

cocks, and place the engineer's brake valve in *lap position.* It is a well-known fact that if the engine is reversed while running the cylinders are converted into air compressors, receiving air through the nozzles and forcing it into the steam chest, thence through the pipe into the main reservoir. To throw out of service, place the reverse lever in the forward motion and pull the lever in the cab backwards. Never under any circumstances must the engine throttle be open or the air brake system will be charged with steam which quickly condenses into water which would cause poor air brake service as it could pass into the air brake system.

The LeChatelier or Water Brake.—This brake was invented about fifty years ago by a Frenchman, whose name it still bears. It is highly recommended for general use in mountainous districts on account of (1) its efficiency, (2) avoiding the trouble so generally experienced with the driving wheel tires heating and expanding on account of the friction between the brake shoes and tires with the ordinary brake. It is very inexpensive and simple to apply. It is most generally referred to as the "water brake," although it is not water, but wet steam that is introduced into the cylinders. The principles involved are very much similar to those employed in the operation of the Sweeney Air Compressor. When the engine is reversed while running the cylinders are converted into air pumps, and greatly retard the speed of the engine. Before the advent of the air brake it was almost

the universal means employed to stop the engine and aid in holding a train. But this method of using the reverse lever had serious objections; as was stated above, the cylinders were converted into air pumps; to fill the vacuum thus created in the cylinders behind the moving piston, hot gases, cinders and smoke from the smokebox were drawn in. This of course was very objectionable and something had to be devised to supply the place of these hot gases. This led to the invention of

LECHATELIER OR WATER BRAKE

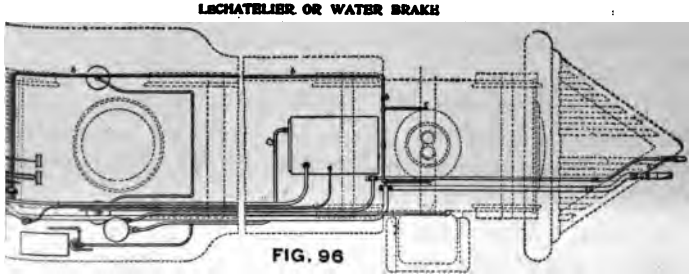


FIG. 96

the water brake by LeChatelier, who used a jet of wet steam in the exhaust ports, which filled the vacuum in the cylinders instead of gases.

Construction.—Its construction and application is clearly shown in Figure 96. It is composed of a globe valve *a* and pipe *b* which is divided into two pipes *c, c,* the latter entering the exhaust pipes as shown. The globe valve in the boiler head should be set within easy reach of the engineer and just below the water line in the boiler. In conjunction with the last statement it may not appear clear to some why it is asserted that steam is used in the

cylinders, and yet the globe valve connection is below the water line. This is explained by the fact that water will boil under atmospheric pressure or in the open air at a temperature of 212°F and be converted into steam. When the steam is up to a pressure of 175 pounds the boiling point of the water is 377°F; when it is released into the exhaust ports, the temperature being above the boiling point, it flashes into steam as it enters the cylinders.

To Operate.—First cut out the air driver brake. Open the cylinder cocks. Close the throttle valve and open the globe valve of the water brake about a quarter of a turn, then place the reverse lever several notches back of the center of the quadrant, and note the density of the steam by its color as it issues from the cylinder cocks. If it does not have a damp or dense white color the water valve must be opened until it does; if on the contrary water is thrown from the stack the water valve is opened too wide. Then the reverse lever should be moved backward until the required braking power is exerted; the further back the lever is placed, the greater the retardation of speed. Thus when placed in but the first or second notch back of the center, a very little braking power is obtained; when placed in the extreme back notch it holds the most. To cut out of service again, close the water globe valve, and move the reverse lever slowly to forward motion. If it is desired to use the water brake while the engine is running backward, reverse the operations explained above.

When once put into service coming down a grade it should never be cut out of service and then in again. If the braking power exerted is too great it should be diminished by moving the reverse lever toward the center notch. When used intermittingly, the valve and cylinders will require a great deal of oil to keep from cutting, as each time the water brake is used it will leave the cylinders and valve dry of oil, but as long as the brake is in service, the steam, being a lubricant, acts as a safeguard against cutting.

Its Efficiency.—Careful tests under varying conditions demonstrate the fact that the water brake will hold a very large part of the tonnage the engine is capable of hauling up the same grade.

CHAPTER XXI.

BRAKE TESTS.

Tests conducted under very exacting circumstances offer very good food for thought and study, besides giving the exact results in actual practice. A review of the most important will be given under this heading.

High Speed Brake.—A very interesting test of the high speed brake was made Oct. 1 and 2 in the year of 1894, *on a descending grade of 29 feet to the mile,* near Ship Road, Pa., by the Pennsylvania Railroad Co. The train consisted of six ordinary passenger coaches, the total weight of the train being 564,000 pounds. No alterations whatever were made during the test, the different pressures of air in train-line and main reservoir being obtained by cutting into service different pump governors and feed valves. There was no "approximate" or guess work about the speed, as a correct and tested speed recorder was used for measuring the speed of the train. The spot at which the brakes were applied was also exact, as the brakes were not applied by the engineer, but by a valve in the train-line coming in contact with a trip arrangement fastened to a tie in the road bed; this made it possible to measure accurately the distance the train ran after the brakes were applied. The first day's tests were made as near as possible at a speed of 45 miles an hour, wh

second day's tests a speed as near as pos-
o 60 miles was attained. Although on none
trials was exactly the speed of 45 or 60 miles
ır attained, the corresponding length of stop
and 60 miles an hour was computed and is
in an adjoining column:

t Day—

s in ine.	Actual speed in miles per hour.	Actual length of stop in feet.	Computed length of stop at 45 miles per hour.	Average length of stop.
	QUICK-ACTION BRAKE.			
	47¾	776	694	688
	45½	697	683	
	HIGH-SPEED BRAKE.			
	46¾	584	567	567
	46¼	610	580	
	47	601	555	

in feet in favor of the High-speed Brake..... 121

ıd Day—

s in ine.	Actual speed in miles per hour.	Actual length of stop in feet.	Computed length of stop at 60 miles per hour.	Average length of stop.
	QUICK-ACTION BRAKE.			
	60¾	1,697	1,658	1,622
	61½	1,634	1,558	
	58¾	1,584	1,649	
	HIGH-SPEED BRAKE.			
	61¼	1,372	1,319	1,234
	61½	1,361	1,299	
	61½	1,330	1,269	
	58¼	1,125	1,189	
	64¼	1,202	1,155	

in feet in favor of High-speed brake..... 388

CHAPTER XXII.

PIPING.

To pipe an engine and cars properly is of vital importance to the desired action of the air brake. This, however, is a portion of the air brake "make up" which is occasionally neglected. Under no condition should the pipe be used without first being thoroughly cleaned. To do this, the pipe should be lightly tapped to loosen the scale and dirt and then be blown out with steam or air. The sizes of pipe given in the air brake catalogues should in all cases be strictly adhered to. It will be noted that sizes of pipe given for freight cars are generally larger than those to be used on passenger coaches. This is for several reasons: (1) it will cause a more rapid reduction or increase of pressure at the rear portion of the train on account of air traveling through the large pipe more quickly; the larger the pipe the less friction the air will encounter in its passage through it; (2) a freight car is considerably shorter than a passenger car, thus the large pipe makes the volume of air in the train more equal to that in the smaller pipe, used on the passenger coaches, which are longer. When pipes are cut a flare or fin will be created in the inside of the pipe, considerably reducing its size; this in all cases should be care-

ılly removed with reamer. When too many of ıese are allowed to remain through the pipe sys- ım it will prevent the emergency action of the 'akes. When using red lead or any substance to ake a joint it should always be put on the out- le thread, or the thread to be screwed in, as this ll prevent it from being forced into the pipe and ısing defects in the brake system.

Whenever practicable, when necessary to change e direction of the pipe, it should be done by long, sy *bends,* instead of *elbows* or *short bends,* as e frictional resistance caused by them retards e flow of air through the pipes. Care should be ken to have all pipes rigidly clamped so as to event vibration or moving, which causes the ints to leak or holes become chafed in the pipes. fter the pipe work is applied and completed it ıould be thoroughly tested under full pressure ır leaks by use of soapsuds applied to the joints, r by the use of a lighted torch and later painted ıith rust-proof paint.

CHAPTER XXIII.

LUBRICANTS.

The following is a list of the lubricants that have proved most satisfactory in the different parts of the brake system:

Steam Cylinder of Pump—Valve oil.

Air Cylinder of Pump—Valve oil.

Brake Valve—High grade machine oil.

Triple Valve—High grade engine oil.

Brake Cylinder—A light grease that will not flow in summer or become thick in winter.

CHAPTER XXIV.

ISEASES—CAUSES, SYMPTOMS AND CURES.

oductory—"What's the matter with my air
!" If not said aloud, you may have often
t to yourself, and perhaps oftentimes de-
ıgly. When your brakes do not work prop-
ıere is something wrong. Do not imagine
is a peculiarity of the brake that cannot
edied. Most generally it can; but you must
ıow what is the matter. Every erratic ac-
a symptom of distress, or future failure,
ıould be noticed by you and you should at
udy the action to find out the cause for it.
ıakes it? Where does it come from? When
ve decided what the cause is, do what you
right it. If parts are broken or defects
ıt cannot be repaired by you, report them
elligent manner. This enables the repair
go at once to the affected parts without
considerable time trying to find out
e trouble is. To be able to do this, one
dy every part of the equipment and
d what it does, *and why.*

Pumps.

p is the heart and life of the air brake
hen the pump is diseased, the whole

system is unreliable, and when it stops, the "whole thing stops," as its duty is to supply the air—the life of the air brake system. Its life, efficiency, diseases or death depends to a great extent upon the care and handling it receives. It is really wonderful how long and how good service a pump will give when properly cared for. The air pump, unlike a great many other things, seldom dies a sudden death. It generally puts up a hard fight to keep running, giving warning by erratic action at times for months in advance. But oftentimes no attention to these signals of distress is given until open rebellion takes place and the delay of an important train is the result. Whenever your pump does not act exactly right, locate the difficulty and have it remedied at once, for it will surely give you trouble later on. Defects of the pump appear in two distinct portions: (1) trouble in the steam cylinder; (2) the air cylinder. These are most generally spoken of as the *steam* or *air* end, as the case may be. As the 6 inch Westinghouse pump is practically obsolete, it will not be considered in this treatise. And as the New York pumps are of the same construction as the Westinghouse it will not be necessary to treat them separately.

Temporary "Stoppage."—Under this head will be considered the defects that will often cause a pump to stop, but which most generally can be overcome and the pump started by tapping on the steam cylinder head. Whenever your pump requires frequent tapping to keep it working and

you are unable to locate and overcome the entire trouble yourself, have it examined, explaining its action to the air brake repair man, or sooner or later it may stop altogether.

Eight Inch Pumps (Figure 2).—One of the most frequent causes of temporary stoppage is:

Lack of oil in the reversing piston 23, Figure 2. This is due to its position, and generally very little oil finds its way there. If the pump requires very frequent tapping to keep it going, take off the reversing cylinder cap 21, Figure 2, and oil with a little valve oil. After oiling and before replacing the cap, see if the trouble was not caused by broken packing rings 24 or *a*, Figure 2.

Broken Reversing Piston Rod.—This will often allow the pump to act in this way, but generally it will cause complete stoppage; but if well oiled it can often be kept working to the end of the run.

Other Causes.—(1) Loose nut on top of main steam valve, which will generally manifest itself by a continuous blow through the exhaust; (2) the reversing plate 18, Figure 2, or the button on the end of the spindle 17, becoming badly worn, so as not to properly pull down the reversing valve.

The 9½ Inch and Duplex.—Experience has shown little trouble with temporary stoppage with either of these pumps, except the trouble with the reversing plates and buttons as explained for the 8 inch pump or worn *small differential piston packing rings* 80 (Figure 5) of the 9½ inch pump. When it stops try tapping, if that does not start it, see the following article.

Complete Stoppage.—If it cannot be started by tapping, try shutting off the steam supply, opening the drain cocks and then quickly opening the steam supply again; if this fails, the next step to be taken is to find out whether the cause of stoppage is a *defect of the pump or the governor;* as a defect in the latter may have caused it to shut off the steam valve. *How to test* for this will be explained for each style of pump following.

If there is a constant blow from the relief port *c* (Figure 13) in the governor, it is a sure indication that it is the fault of the governor. If the governor air pipe is connected with the train-line, cut out the brake valve by closing the cock in the train-line just below the valve and place the brake handle in service position; as this reduces the pressure in chamber *a* (Figure 13) of the governor. If the governor air pipe is connected with the main reservoir pressure, disconnect the air pipe leading to the governor, so as to let the air out of it. If the *pump* starts, the trouble is in the *governor;* if it does not, the trouble is with the *pump.*

Another method is to partially disconnect the steam supply pipe at the union next the pump or open the steam cylinder drain cock; if there is a full pressure of steam there, and it does not diminish, when the cock is left open for several seconds, the trouble is in the pump. If there is no steam there, or very little, the fault is with

the governor, which has shut off the steam supply to the pump.

8 *Inch Pump.*—After the trouble has been found to be with the pump, and the cause is not apparent, take off the cap 21 (Figure 2) of the reversing piston and proceed as explained in article, *Lack of Oil,* under head of *Temporary "Stoppage."* If this treatment fails and no trouble is found there, take off the bottom head of the air cylinder and see if the nut 58 (Figure 2) has not worked loose or fallen off. If you fail to find anything wrong there, the trouble will most likely be beyond repair on the road. The most usual causes of complete stoppage are

(1) *Lack of Oil* and

(2) *Loose Air Piston Rod Nut* 58 (Figure 2). (Both of these subjects are treated above.)

(3) *Broken Stop Pin* 50 (Figure 2). If the stop pin 50 is broken or becomes badly worn, so that it allows the main valve to travel too far down, leaving the packing rings of the small lower valve to catch in the bushing, it will prevent the valve from making the up stroke and the pump will stop. Sometimes they can be dislodged and the pump started by tapping the bushing lightly with a hammer; if this fails, the cylinder must be removed from the center piece; this of course must not be attempted on the road.

(4) *Loose Nut on Main Steam Valve.*—The small nut on top of the main steam valve may have worked loose. This should be made to turn in very hard and riveted fast.

(5) *The Small Port to the Reversing Valve Chamber* may have become gummed up or obstructed in some way.

(6) *Badly worn Reversing Plate.*—If the reversing plates (bolted to the upper steam piston) become loose or badly worn, or the button on the end of the reversing spindle 17 (Figure 2) becomes badly worn, the pump will stop at the end of the down stroke. It is the lower side of the reversing plate 18 (Figure 2) and the button of the spindle that wear the fastest, thus failing to draw the reversing valve down. When steam is shut off from the pump, the reversing valve will often drop down of its own accord; so if your pump stops at the end of the downward stroke, and by shutting off and turning on the steam, it makes an up and down stroke again, and then stops, it is almost a certain indication that this is the trouble.

(7) *If the Packing Rings in the Main Valve or Reversing Piston break* and get out of place, they may become lodged in such a way as to prevent the movement of the valve. This can generally be located and repaired by taking off the reversing piston cap 21 (Figure 2) or the top head.

The repair of most of the latter troubles should not be attempted on the road, and are cases for the air-brake repair-man.

9½ *Inch Pump.*—Very little trouble on account of stopping has occurred with the 9½ inch pump and these are all practically beyond the repair o

the engineer while on the road. As all the valve motion is in the upper head, when one of the pumps gives warning of trouble, the head is taken off and another one put on while being overhauled. A bent or broken reversing rod 71 (Figure 4) preventing the valve motion from reversing, a serious leak in the steam passage between *b'* and *b''* into the upper end of the steam cylinder, due to a defective copper gasket not forming the joint between the upper head and cylinder, badly worn reversing plate[1] or spindle button, main piston rod nuts of air piston working loose as explained for 8 inch pump, are the principal causes of complete stoppage.

Duplex Pump.—On account of the simplicity of construction of the duplex or New York pump, very little trouble is experienced with it on account of "stoppage." About the only causes are: (1) Badly worn reversing plates or spindle buttons; (2) loose air piston nuts 74 (Figure 9). Both these troubles are explained under the head of 8 inch pump.

Pounding. (*Westinghouse and New York.*) —This may be due to one or more of a great variety of causes. To ascertain see that there is no water in the cylinder, notice if the pump is loose on the frame or brackets, or the brackets loose on the boiler. If these are found all right, report the pump to be examined for pounding. It will generally be found to be one of the following causes, which are beyond the repair of the engineer while on the road.

Main Piston Striking Cylinder Heads.—The clearance between the piston and cylinder heads is made as small as possible to make a good compressor for the reason that all the air remaining between the piston and the head at the end of the stroke, has been compressed only to expand and be compressed again on the next returning stroke. Anything that will destroy the cushion of air between the piston and the head, such as badly worn packing rings or *air valves stuck* or broken or leaking very badly, thus destroys the cushion, or the air piston nuts (Westinghouse 8 inch, 50, Figure 2; 9½ inch, 68, Figure 5; duplex, 74, Figure 9) *working loose* will permit the piston to strike the head and pound.

Heating: (*Westinghouse and New York.*)—This is frequently due to the air valves being badly gummed or ports clogged from excessive use of oil in the air cylinder mixed with the dust drawn in through the strainer. You can generally tell if this is the cause by noting if the pump can be made to work fast and free. If it is inclined to work slowly and laboriously, this will almost always be found the cause. The remedy is

Cleaning the Pump.—Disconnect the air discharge pipe at the union with the main reservoir, and work a potash or lye solution through the pump by starting it to work slowly, allowing the pump to draw the solution through the air-inlet port. Catch the solution again with the tank bucket or other vessel as it comes out of the dis-

pe, and feed it through the pump 3 or 4
hen work through the pump in the same
considerable quantity of clean hot water
thoroughly wash out all the potash. If
allowed to remain, it will work back
the system and cause a great deal of
ating out the gaskets, hose, etc. Some
use of simply hot, soapy water, which
er the purpose very well, if the valves
ummed up too badly.

Piston Packing Rings will cause a pump
nore quickly and be more troublesome
other cause. This is due to the "churn-
the air and is detected by running the
derately and placing the hand lightly
t to exclude all the air) over the air-
s as air is drawn in during the begin-
rst half of each stroke and none during
inder of the stroke.

l Cup Test for Leaky Cylinder Rings, ½" Pumps.—Run the pump at 30 strokes
ite against 90 pounds main reservoir
open the oil cups, if air blows out on
stroke the rings leak. Why the piston
ws in air during part of the stroke or
k through the oil cup is explained thus:
g the piston is to be at the top of the
and starting on the down stroke. As
downward it creates a space or vacuum
ist be filled, so air is drawn from the
but as the piston moves on down, it be-
ompress air in the lower end which, in-

stead of becoming compressed very hard, leaks past the defective packing ring into the upper end. So no more air need be taken from the outside to fill the vacuum created by the downward stroke of the piston, but it comes from the compressed air in the other end of the cylinder, which should have been forced into the main reservoir. The oil cup test is for the same reason. The air that blows back goes out through the oil cup on the down stroke.

Excessive Pressure and "Racing."—(See article under head of *Required Speed*, later on).

Want of Oil.—Although this is a very unfrequent cause, nevertheless if a pump is required to do fast and heavy work without sufficient oil, it will heat, the same as anything else subjected to friction. The air end of the air pump is credited with using a very small amount of oil on account of its getting more oil than is really supposed. A well oiled steam cylinder on a pump, that is not kept very well or snugly packed, or when a piston swab is used, will leak enough oil down the piston rod into the air cylinder to keep it from groaning without giving it oil through the cup. But it must not be inferred that, because you did not give it any oil, it was running without it. Ofttimes a pump with a long train will start to groan and heat for the sole want of oil.

The duplex pump air cylinders require more frequent oiling on account of their position. Being over the steam cylinder, they do not receive so much oil from them as the Westinghouse.

Never under any circumstances oil the pump rough the air-inlet ports. Many engineers do is because they think there is no other way hile the pump is running. Slow the pump down little, open the oil cup, allowing it to remain pen until the pump has made several strokes; his is to blow out any dirt that may be in it, which ould otherwise be drawn into the air cylinder ith the oil; then fill the oil cup, or put in the mount desired, and on the downward stroke pen it, and the oil will be drawn in. Never hould there be more than two oil cups full fed the air cylinder at one oiling, and always use alve oil. If the pump is very hot, do not give ny oil until its temperature has been reduced by llowing the pump to run slowly for a while.

Other Causes Are: Leakage back from main eservoir, leakage past the receiving valves, leakge at piston rod stuffing box, air valves stuck hut, etc., which will all be treated in the section nder the head of *Low Effective Capacity*, as anyhing that will cause the pump to work faster, ithout discharging the air compressed into the ain reservoir and retaining it there, will cause pump to heat more or less.

Low Effective Capacity.—This trouble is usully in the air end of the pump, and as a rule ill always cause the pump to heat more or less.

Leakage Back From Main Reservoir.—This will e caused by a broken discharge valve, a defecive valve or seat, or dirt or gum on the seat. his defect will manifest itself in the following

ways: (1) Pump working fairly rapidly, t not pumping much air, as only one end of t pump is retaining the air it compressed in t main reservoir; (2) an *uneven stroke of t pump,* the one *away* from the defective va being the rapid one; (3) little air will be dra in at the inlet ports while the pump is maki the rapid stroke.

To Test: (*Westinghouse.*)—Stop the pun open the oil cup and remove the plug in the b tom air cylinder head. If air continues to bl through the oil cup the upper discharge val leaks. If air blows continuously through t opening in the cylinder head the lower dischar valve leaks.

To Test: (*New York.*)—For high pressure c inder discharge valve; when main reservoir pr sure is about the standard, shut off the pump that both pistons stop at the bottom of their c inders; then open the high pressure cylinder cups; if a steady blow occurs from the cup a the piston remains stationary, the upper final d charge valve 13 (Figure 9) is leaking; but if blow occurs, and the piston moves upward, t lower or final discharge valve 14 (Figure 9) lea

To Test the Upper Discharge Valve 11 of t Low Pressure Cylinder, run the pump rat slowly, and as the high pressure piston starts the upward stroke, open the low pressure cylin oil cup 53 (Figure 9); if a blow occurs at this while the pump is making the up stroke, the va leaks. *To test the lower discharge valve 12* (F

ure 9) of the low pressure cylinder, take a nail or a piece of wire and unseat the lower receiving valve *10* (Figure 9), as the high pressure piston is making the down stroke; if a blow occurs from the air-inlets, the valve leaks.

The Remedy: (*Westinghouse.*)—If you locate the trouble in the top end, screw off the nut (8 inch, 29; 9½ inch, 89; duplex, 44) and remove the air valve. If there is nothing the matter but dirt or gum on the seat, clean off and replace. If you find the valve broken put in another. If you have no valve and can get none, nothing can be done better than to let it continue "one-sided" until a round-house is reached, where the valves can be removed. If the trouble is located in the bottom end, remove the nut (8 inch, 34; 9½ inch, 88; duplex, 46) the valve will come with it, as the nut is also the bushing and contains the valve. Proceed as explained for upper valve.

Leakage Past the Inlet or Receiving Valves.—This will occur from the same causes as leakage back from main reservoir and with nearly the same symptoms and results.

To Test: With 8 inch and Duplex pumps, hold the hand lightly over the air-inlet ports; if the air is drawn in and then forced out again at one of the inlets, that valve will be the defective one. *With a 9½ inch pump* the trouble cannot be located in the above way, as both ends of the cylinder draw air through the same inlet, consequently air that is forced out through the end with the defective valve will be drawn in again

at the opposite end, passing through the passage F and is not forced out through the inlet. This makes the trouble more difficult to locate than with the 8 inch or duplex pumps. Place the hand lightly over the inlet port W (Figure 5) and the suction will be decidedly less while the pump is making the quick stroke, and the faulty valve will be the one *toward* which the piston is traveling.

Air Valve Stuck.—Symptoms: If one valve is stuck: (1) uneven stroke of the pump; (2) the pump will generally pound on the fast stroke; (3) pump heating; (4) no suction at air inlet port at one stroke of the pump. If both receiving valves or both discharge valves become stuck, or the inlet port or ports, or discharge pipe becomes stopped or frozen up, the symptoms will be: (1) no suction at the air-inlet port; (2) the air gauge hands will not move up.

To Test.—Place the hand lightly upon the air-inlet; if the stroke of the pump is uneven, and there is *no suction* when the pump is making the *slow stroke,* then the receiving valve *away* from which the piston is moving is stuck. But if there *is* a suction when the pump is making the slow stroke and no suction when the pump is making the *fast stroke,* then the discharge valve, away from which the piston is moving, is stuck. If the strokes of the pump are even and there is no suction whatever at the air-inlet, then either both receiving or both discharge valves, or the

ir-inlet or discharge pipe is either stopped or rozen up, it is best to proceed as follows:

The Remedy.—Try tapping the cages lightly; this does not start the valve, then screw out the ir-inlet strainer W (Figure 5) to see if the rouble is there. The next move should be to disonnect the discharge pipe at the union connecion to the pump. If the pump sucks air at the let and discharges air at the brake, it will be lear that the discharge pipe between there and ie main reservoir is stopped up. If the pump till refuses to work properly an examination of ie air valves must be made.

Leaking Piston Packing Rings.—This is one of ie most frequent causes of a poor pump; it is lso one of the most common defects that causes pump to heat, therefore it was treated under ie head of *Heating* heretofore.

Air Cylinder Leaks.—Any leakage around ither of the air cylinder heads, air valves, cages r caps, or discharge pipe union, reduces the mount of air compressed, and impairs the effiiency of it and must be run faster to supply the aste.

Pump Cannot Be Made to Work Fast.—This is ue to: (1) air valves not having lift enough; 2) air valves or passages gummed up; (3) steam upply to pump being insufficient; (4) the steam haust from the pump being partially obstructed.

Proper Lift of Air Valves.—It should be reembered that the air receiving and discharge lves in the 8 inch pump are of different sizes;

the receiving valve, being the smaller, requires a lift of 1/8 inch, while the discharge valve, being larger, only requires a lift of 3/32 inch. But both the receiving and discharge valves of the 9½ inch pump, being alike, they are all set at 3/32 inch lift. The proper lift of all the air valves in the No. 1 and No. 2 duplex pumps is 1/16. The lift of the No. 5 duplex pump air valves is 5/16 inch. Any variation in either direction from these standards will cause the pump to work improperly. Too much lift causing the pump to pound, and too little lift will impair its efficiency, causing it to run more slowly and heat. If the valves are uneven in the lift, the pump will have an unequal stroke, having a fast stroke in one direction and slower one in the opposite.

"Jiggling" or "Half Stroke." (*Westinghouse and New York.*)—This term is generally used by railroad men to designate a sort of jumping, short stroke of the pump, the piston merely starting on its stroke and then returning, only to repeat the operations in rapid succession. Any disarrangement of the reversing valve or valve stem, or a badly worn valve or seat or the stem fitting loosely where it passes through the bushing into the steam cap, will cause the pump to "jiggle," as it will allow the stem to drop back of its own weight after being pushed up, thus immediately reversing the pump again. This accounts for the fact that a pump most generally "jiggles" with the piston at the top of the stroke, as it is in this position that the reversing plate shoves or

draws the stem upward, and then as its support moves away from it, through being defective, it drops down again, when it should, if in proper repair, remain up until the reversing plate draws it down as the piston completes its downward stroke. If the reversing stem gets bent, it will cause the pump to reverse at the point where the bent part rubs against the reversing plate, which causes the rod to be moved too soon, reversing the pump before the stroke is completed.

Blowing Through the Exhaust.—The blowing of steam through the exhaust, comes from a variety of causes, all of which are very wasteful of steam, impair the efficiency of the pump, and will gradually grow worse. There are two kinds of blows, a constant and intermittent. Each will be considered separately. There are very few of the defects under this head that the engineer would be expected to repair. So when your pump blows, have it examined and repaired by the air brake repair men.

Constant Blow. 8 Inch Pump. Leaky Reversing Valve.—If the reversing valve 18 (Figure 2) or its seat, becomes worn so that it leaks, steam will blow through ports *c, ff,* into *g,* thence through the exhaust, causing a constant blow.

Leaky Main Valve Piston Rings.—If the packing rings in either of the pistons leak, steam can escape constantly past them into the ports *f, f, f, f,* into ports *g* (Figure 2), thence through the exhaust. These rings as well as the bushing need occasional renewing.

Leaky Piston Packing Rings.—Badly wo broken or defective piston rings will cause t most wasteful blow of all, as it produces a co stant heavy blow. As one end of the cylinder always open direct to the exhaust, and the oth always full of steam, the steam has an uninte rupted passage. These should at once be r newed.

9½ *Inch Pump. Leaky Slide Valve.*—If t slide valve 83 (Figure 5) leaks, it will cause constant blow through the exhaust while the pum is working.

Leaky Small Main Piston Valve Rings.—If t rings of piston valve 79 (Figure 5) become wor or broken, so as to cause them to leak, it wi cause a constant blow; as steam leaking past pis ton 79 (Figure 5) into chamber E (Figure 5 blows through port *t* (Figure 5), which is alway open through the exhaust to the atmosphere.

Leaky Gasket.—The gasket forming the join between the top cylinder head and cylinder ma leak steam direct through from the supply pass age to the exhaust passage; but this seldom oc curs without also leaking to the atmospher around the outside of the head where it can b seen. This is remedied by putting in a ne gasket.

Leaky Reverse Valve.—If the reversing valv 72 (Figure 5) leaks, steam would blow throug port *f* into the exhaust port *d*. Since port *f* co nects directly with exhaust port *d*, there woul be a constant blow.

Leaky Piston Packing Rings.—See same subject for 8 inch pump.

Duplex Pump. Leaky Reversing Valve.—If the reversing valves 5 and 6 (Figure 9) or their seats become badly worn so that they leak, steam can escape directly into the exhaust, and produce a constant blow, which will rapidly grow worse.

Leaky Piston Packing Rings.—See same subject for 8 inch pump.

8 Inch Pump. Reversing Rod in Cap Nuts 20 Leaking.—If the top end of the reversing rod 17 (Figure 2) that projects up into the cap nut 20 becomes worn, steam will leak past it into the port and thence into the upper end of the steam cylinder, where it will cause a blow, while the pump is making the up stroke, as the exhaust of that end of the cylinder is then open. On the downward movement of the piston it leaks past into the cylinder just the same, but is not wasted, and no blow occurs, as the upper end of the cylinder exhaust is then closed.

Reversing Piston Rings Leaking.—If the packing rings of the reversing piston 23 (Figure 2) allow steam to leak past, it will escape through the small ports at the bottom of the reversing chamber, thence through the passage *f, f,* to *g* and the exhaust, causing a blow only during the up stroke of the pump. This is on account of there only being steam above the reversing piston 23 or in chamber D while the pump is making the up stroke. This is remedied by renewing the packing rings.

9½ Inch Pump. Reversing Rod in Cap Nut 7 Leaking.—If the top end of reversing rod 7 (Figure 5) becomes worn, so that steam will lea past into port *x* and thence down through th reversing valve bushing passage into the top steam cylinder of the pump, it will cause a blow whil the pump is making the up stroke, as the exhaus of that end of the pump is then open.

Leaky Gasket.—If the gasket between the to head and cylinder is not tight, steam may escap into the exhaust passage *d' d''* (Figure 5), caus ing a blow while the pump is making the dow stroke. To remedy, tighten up the nuts on th top head; if this does not stop the leak, put in a new gasket.

Duplex Pump. Reversing Rods in Cap Nuts 15 Leaking.—When the ends of the reversing rods become worn so that they leak, steam will escape by them into the cap nuts 15 (Figure 9), thence through the passage drilled through the rods to the lower ends of the steam cylinder, thence through the exhaust, causing a blow when either piston is making the downward stroke.

When Pump Works Water Through the Steam Exhaust.—When the pump, while working, gives trouble by collecting excessive moisture, or throws water out of the exhaust, it is very evi dent that the dry-pipe in the boiler leading to th air pump throttle valve is leaking or the steam supply is drawn from too near the water line. I the latter case, the trouble can be remedied b making the connection at a higher point. In th

former, the pipe inside the boiler must be examined and repaired. In either case the steam end will require a great deal of oil to keep it from groaning.

The Pump Governor.

The governor is the automatic controlling throttle of the pump. Its duty is to shut off the supply of steam, thus preventing it from compressing more air, or air to a higher pressure than is wanted or required for efficient braking. It is subject to disorders and defects for which the pump is oftentimes blamed, and causes considerable trouble to maintain the proper pressure when out of order. It is, therefore, necessary that we should be familiar with its defects and remedies. It is necessary that the governor be sensitive. When it requires the reduction of several pounds in the air pressure before it will permit the pump to go to work again, it should be considered out of order. With the reduction of half a pound, a governor in first-class order will set the pump to work. Another point always to remember is, never start to "tear the governor to pieces" until you are sure it is the governor that stopped the pump. The pump may have stopped working on account of a defect of its own. How to ascertain which it is, without taking apart, is fully described under the head of *Pumps*, in article *Complete Stoppage*.

Improved Westinghouse and New York Governors.—As the improved Westinghouse and New

York governors are almost identically the sam in construction and principle, they are cons quently subject to the same diseases, and wi therefore be treated under one head. About th only material difference being the absence in th New York governor of pin valve *m* (Figure 13 Therefore, in the following articles, when the *pi valve* is referred to, it should be read *diaphrag valve* when studying the defects of the New Yor governor.

When the Governor Will Not Permit the Pump to Work.—This is generally the result of one o two causes:

(1) *Governor Piston Stuck in Its Bushing.*—If the bushing of the governor piston 28 (Figure 13) becomes stuck at the lower end of the stroke while the steam passage is closed, it will prevent the pump from starting.

(2) *Pin Valve Leaking Badly.*—If the pin valve *m* (Figure 13) leaks very badly, dirt or scale under the valve, so as to let air into chamber D faster than it can leak out through the relief port *c*, or if there is but a moderate leak through the pin valve, and the relief port becomes partly stopped up, or under any circumstances, if air gets into chambers D and E faster than it can get out, it will hold the valve 26 to its seat, preventing steam from reaching the pump, and therefore keeping it from working. The trouble can be located by a strong and continuous blow of air from the relief port *c*. To remedy, remove the pin valve by unscrewing the spring-box from

aphragm body and thoroughly clean the

n the Governor Will Not Stop the Pump.—
happens unnoticed by the engineer it gen-
results in a bursted hose or pipe. With a
New York brake valve, as the pump will
ue to work and compress air until the train-
ressure is very high. With the feed valve,
brake valve, only the main reservoir pres-
would become excessive, while the brake
remained in running position. When the
handle is thrown into release for the pur-
f releasing the brakes, if a burst hose is
e result, the auxiliaries are overcharged,
efore proceeding far, the brakes begin to
If you should happen to notice the exces-
ressure, shut off the pump, and make a
r of applications until the pressure is re-
to nearly the standard, when the pump
be allowed to run just fast enough to
he pressure as near as possible standard,
n opportunity is afforded to give the gov-
attention. Should a release be necessary
t is still high, care should be exercised not
charge the auxiliaries.

m Valve 26 Held Open.—(Figure 13.) If
um, scale or any solid matter gets on the
f the steam throttle valve 26, preventing
n closing tight, it does not prevent the pin-
m from working, which promptly lifts
the proper main reservoir pressure is at-
allowing air pressure on the top of the

piston 28. This defect is located by the constant blow from the relief port *c* after the main reservoir pressure has reached and passed the standard. To remedy, shut off the steam supply to pump, open the drain cock, screw the governor apart at the lower joint; the dirt can then readily be removed from the seat. It will be found necessary in order to screw apart the governor to disconnect the air pipe leading to it; do this at the union 44.

Occasionally the seat of valve 26 becomes worn so that it requires to be ground in. But in this case it is seldom found to leak badly enough to allow the pump to work much faster than enough to supply the leakage on a fairly long train.

Drip Pipe Stopped or Frozen Up.—It will be remembered that the duty of the governor waste pipe is to provide a means of escape for the steam that may leak up past the stem of steam valve 26 (Figure 13); also for the air that leaks down past the packing ring 29 of piston 28. When this pipe becomes stopped up, there is no way of escape for the pressure accumulated there, and the valve 26 is prevented from closing so the pump continues to work. To locate this trouble, there is no escape of steam or air from the end of the drip pipe; if there is not and air is blowing from the relief port *c*, disconnect the waste pipe close to the governor and run without it till the pipe can be cleaned out. Bend the pipe so that the end is near the boiler which does away

with the annoyance of this pipe freezing up in winter, as is often the case.

Pin or Diaphragm Valve Held on Its Seat.—When the piston valve is too long, or the edge of the diaphragm body so reduced that the pin valve is held on its seat when the spring-box is screwed down tight, there will be nothing to close valve 26 and the pump will continue to work. To ascertain if this is the trouble, slack off on the spring-box and if the governor does not then stop the trouble is somewhere else.

Westinghouse Old Style Governor.—(Figure 15.) The old style governor is subject to all the defects enumerated under the head *Improved Governor,* and in addition has another one: the buckling of diaphragm 19. It must be remembered, however, that the old style governor has no relief port *c,* but instead, the air that is left in chamber E when the pin valve closes, is expected to leak past the piston packing ring, which is purposely made to fit moderately loose, and thence out through the drip pipe.

Buckling of Diaphragm.—The diaphragm 19 in the old governor (Figure 15) is not supported as in the new governor, in consequence of which it sometimes gets loose around the edge by the pressure raising it up until it "buckles." You will know when this occurs by its peculiar and annoying action,—continually stopping the pump at any pressure, probably one time stopping it long before the standard, and the next time not until long after it is exceeded.

Cutting Out the Governor. (*Westinghouse and New York.*)—If the governor is beyond repair on the road, regulate the pump by the throttle valve. To do so put a blind gasket into the air pipe leading to the pump governor. Any method that will prevent the air from reaching the governor will "cut it out."

Slow in Permitting Pump to Work.—It is necessary that the governor should be sensitive in letting the pump work again after it has stopped when standard pressure was attained, but reduced on account of leakage. Governors have been known to permit several pounds of air to leak away before letting the pump go to work again. The cause of this will nearly always be found to be the

Relief Port C stopped up.—(Figure 13.) When the relief port *c* becomes stopped up with dirt or gum, and the pin valve *m* has raised to stop the pump by the air forcing the piston 28 down, it will be seen that, after the pin valve has performed its duty in closing at the proper time the pump will not go to work for some little time afterwards as the air will be confined above the piston. Whenever the pump allows the air pressure to reduce several pounds before going to work again, always see if the relief port is open. The improved governor, when in perfect working order, will only allow the pressure to reduce about half a pound before starting the pump. With the old style governor, if the packing ring

piston is too tight the same trouble will

Regulate or Set the Governor.—Some may his should not be treated under the head of ; but from an engineers' point of view it ; because when it is not set to stop the at the proper pressure there is "something the governor not right." To regulate the or take off the lock nut, and if it allows the to compress too much air, loosen the ad- screw; when it stops the pump too soon, higher pressure is wanted, tighten the ad- screw.

Main Reservoir.

(*Westinghouse and New York.*)

main reservoir although for one purpose— age for air, performs another important perfection; that of acting as a drain cup r filterer, freeing the air of water, oil, dirt her foreign matter. The greatest defect to it is subject, or, more properly speaking, be considered a "defect" of the engineer ecting to drain it, is the accumulation of er: *The Source of the Moisture.*—The air osphere contains a great deal of moisture er in suspension (while in its "free state"). more free air there is compressed in a space, the more water or moisture there there. This is like squeezing a soaked , as the particles are crowded together the re is crowded out and falls to the bottom of

the reservoir in the visible form of water. If there were no place for this water to collect, would find its way throughout the whole syste doing damage, preventing the brakes from wor ing properly, and in the winter freezing up, re dering the whole system out of service. Co paratively little of this water comes from th leakage past the piston rod of the steam cylinde Water in the main reservoir has probably bee the cause of many run-aways on grades. It also frequently the cause of brakes sticking, esp cially on long trains, as water takes up space th should be occupied by air.

Leakage.—This is about the only other troubl to which the main reservoir is subject. Ver rarely a leak will be found in the main dru itself; but it must be remembered the main reser voir includes all the piping from the pump to th brake valve; and it is in these pipes that th leaks will mostly be found.

Air Gauge.

The engineer of course is not expected to com pletely test or repair the air gauge; but with th aid of the following suggestions will be able t make such tests as to satisfy himself that th gauge is out of order, and can safely report it so

How to Test the Air Gauge.—Place the brak handle in full release and watch the gauge whil the pressure is being pumped up. If both hand do not move up exactly together, the gauge is ou of order; as in this position both main reservoi

and train-line pressure remain equal. When making brake application, sometimes the gauge hand sticks and does not register the reductions. This can be quickly told by jarring the gauge lightly after the reduction. Report the gauge to be tested. The most common defects are: (1) Hand loose on pivot, (2) adjusting lever moved, (3) hair spring broken, (4) ratchet badly worn, (5) moving parts gummed up, (6) hands bent, thus interfering with each other or rubbing on the dial or glass. Gauges are usually compared with a test gauge and if found defective are removed and repaired.

Engineers' Brake Valve (Westinghouse).

As in the previous article instructions are given how to test for a defective gauge; the article under this head will be treated with the presumption that the air gauge is correct. The time a valve will give good service without repair or attention varies so much with the kind of service, position of the valve and handling of it, that a limit cannot be stated nearer than to say, "from one to six months." The brake valve on a switch engine will require attention much oftener than in freight or passenger service.

Brake Handle Works Hard.—This is generally due to one or two causes. (1) The rotary may require *cleaning* and *oiling*. (2) The *nut* that holds the brake handle may be screwed down *too tight*. In the latter case of course all that is necessary is to loosen up the nut a little. If these do not

help (3) the rotary may have a heavy bearing around the outside edge, which should be slightly reduced with a mild scraper and reground to a uniform bearing.

Blow at Train Pipe Exhaust.—D 8, F 6 or G 6. *Constant.* When dirt or gum accumulates around the seat of the train exhaust valve, it will hold the valve from its seat, causing a continual blow from the train-line exhaust. This acts the same as a leak in the train-line, being wasteful of air all the time and when the brakes are applied it will continue gradually to apply them harder. To remove the dirt, try first placing the brake handle in service position or quickly into the emergency position. Repeat several times. If it cannot be moved in this way, report it to the repairman, as the seat may possibly be defective. A blow from either of the above causes will be constant, whether the brake handle is in full release, running position, or lap.

Intermittent or Gradual Blow on Lap Only.—A leak anywhere above the equalizing piston 17 (Chamber D) (Figures 20, 22 and 26,) will cause an intermittent blow at the train pipe exhaust when the valve is on lap only. This leak may be found to be at the gasket 22-D 8 valve or 61 of F 6-32-g6, which can generally be stopped tightening on the bolts that hold the body of the valve together. If not the gasket must be renewed. Or it may be in the pipe leading from the chamber D to the equalizing reservoir, or in the equalizing reservoir itself; another place that is often

verlooked in inspecting for this leak is the pipe ading to the train-line hand of the air-gauge; s this pipe is connected with the equalizing res- voir pipe, a leak at the gauge or in the pipe ill have the same effect, as if in the "little rum" itself. The *reason* this leak will cause is blow while the valve is "lapped" is that in at position no air can get into the equalizing servoir to supply the leak, thus leaving the ain-pipe pressure the greatest, enough so, that e piston is raised, allowing the train-line to ow out of the train-line exhaust an amount ual to the leak from chamber D. It must be derstood, however, that on release or running sition this particular leak will not cause the ston to raise, as the equalizing port *g* is open, us equalizing the pressure above and below the ston. This same leak will also cause a more pid falling of the black hand when a service plication is made.

Defective Gauge Pipe.—Should either pipe ading to the gauge, or the gauge itself, leak dly, plug the gauge pipe so air can not escape d the brakes will work all right again; except at you will have to brake without seeing the duction you are making. If the chamber D Figures 20, 22 and 26) or train-line gauge pipe broken, it might be policy to disconnect the ain reservoir gauge pipe and connect it to the amber D pressure. This would cause the red and to register train-line pressure, while the ain reservoir connection should be plugged.

Equalizing Reservoir Out of Service.—When it becomes necessary to cut the equalizing reservoir out of service on account of it getting knocked off, or a serious leak occurring in it or in the pipe to it, disconnect the pipe at the union next to the brake valve and plug or put in a blind gasket; also plug the train-line exhaust. The brake valve cannot be used in the service position; the emergency port must be used, but in a careful manner.

Braking With Equalizing Reservoir Out of Service.—When the equalizing portion of the brake has been rendered inoperative by "cutting out" the equalizing reservoir by plugging up the pipe leading to it, the brake valve must be considered a three-way cock, and the engineer must "do the equalizing part of it himself." This consists of opening and closing the "train-line exhaust," with the brake handle in emergency position, carefully or slowly, not permitting the air to escape too rapidly. If the valve is opened too wide or too quickly the quick and heavy reduction will result in an emergency application of the brakes. If coupled to a long freight train and the reduction is not quite heavy enough to cause an emergency action, the forward brakes would apply heavily before the rear ones, and the result of this would be that the rear cars (on account of the slack) would crash into the forward ones, damaging the freight and draft rigging. Care and judgment must also be exercised in closing the exhaust. If closed too quickly, the

forward brakes will "kick off." This is due to the friction of the long column of air in the train-line, which starts to flow towards and reduce at the brake valve. When the train-line exhaust is opened, the pressure at the forward end reduces faster than the rear end. If the valve is closed instantly the flow of air from the train-line is stopped abruptly, while the air from the rear end will continue forward, raising the pressure slightly in the forward end of the train-line and release the brakes there. Closing the valve carefully would avoid the surge. It must be remembered that the equalizing feature of the brake-valve is disabled, and the brake handle must be used in emergency position a length of time in proportion to the length of train.

Chamber D Pressure Reduces Too Fast in Service Application.—When the "Chamber D" (Figures 20, 22 and 26) pressure is noticed (by the falling of the black hand of gauge or the severe application of the brakes, when the brake handle is used in service application) to reduce too rapidly, it is generally found to be caused by *water in the Equalizing Reservoir, or the Pipe leading from Chamber D to it being Partly Stopped up.* A leak in the *Equalizing Reservoir* or *Connections* will also cause a more rapid falling of the train-line gauge hand, but in this case it will still continue to fall with a blow at the train-line exhaust after the handle has been returned to lap, which will not be the case should the trouble be due to water in the "little drum."

Anything that will reduce the size of the little drum or obstruct the free flow of air in the pipe leading to it, will cause the train-line gauge to fall rapidly and a correspondingly heavy reduction in the train-line. Another cause for "chamber D" reducing too rapidly is that of having the preliminary exhaust port *e* reamed out or drilled too large. The proper size of this port is 5/64 of an inch diameter.

"Chamber D" Pressure Reduces Too Slow in Service Application.—This is mostly due to the preliminary exhaust port becoming partly stopped or gummed up, thus retarding the discharge of the air from the equalizing reservoir to the atmosphere. This will be remedied by cleaning out the port.

If the preliminary exhaust port is the proper size and there is no obstruction in the port it will reduce "chamber D" pressure from 70 to 50 pounds in about 5 seconds, during a continuous service application.

Leaky Gasket 61.—(Figure 22.) With the F-6 brake valve in addition to the above it may be caused by the Gasket 61 leaking, allowing main reservoir pressure to leak from the passage X to Chamber D. The capacity of the equalizing reservoir is very small, as is also the discharge port in service application. It will be clear that a small leak at this gasket will supply air to Chamber D nearly as fast as let out, and if the leak is bad, the equalizing piston will not raise to reduce the train-line pressure, in which event the

rakes cannot be applied at all in service position. *To Test*: If there is a leak at this gasket t can readily be detected by the black gauge hand ıoving upwards toward the red one after the alve has been lapped; or reduce chamber D ressure to zero, if the blow continues through he preliminary exhaust, it is a fair indication f the leak described.

Leaky Equalizing Piston.—The packing ring f the equalizing piston is supposed to leak some o that with the handle on lap, the "Chamber D" ressure can slowly equalize with the train-line ressure. But sometimes it becomes worn so as o leak too much, in which case it will manifest self in either of two ways: (1) By causing the low application of the brakes in service position n account of the train-line pressure leaking up ıto chamber D nearly as fast as it is let out. 2) By recharging the "chamber D" while the rain-line pressure is reducing on long trains, fter the handle is placed on lap. *To Test*: (1) Vith full pressure place the handle on "lap." lave some one open the train-line angle cock, hus reducing all of the train-line pressure; the eaky piston ring will now allow "chamber D" ressure to flow into the train-line; the gauge ill indicate the amount of the leak. (2) Careılly watch the gauge when an application on a ng train has been made, and the handle placed on lap"; if the ring leaks the black hand will ise till the train-line exhaust completes its reıction. This latter test, however, includes a

test of gasket 61 or 32 (Figures 22 and 26). When the piston raises it makes a seat on the gasket, thus helping the ring to make a joint. Owing to the help of the gasket, a leaky piston ring will develop more leakage on the first test than the second one.

Leaky Rotary Valve or Seats.—These usually allow main reservoir air to get into the train-pipe when it should not. It causes a release of brakes "on lap" and a loss of excess pressure on "Running Position." *1st Test*: To test for a leaky rotary valve, start the pump working with the brake handle in lap position. If the black or train-line hand of the gauge raises or if there is a blow at the train-pipe or emergency exhaust, the rotary valve leaks. Since with the brake handle in lap all the ports being blanked air could not get further than the rotary if it were tight. *2nd Test.—Most Practical*: To make the test while on the road or at the terminal and where the brake system is charged with air; close the angle cock back of engine so as to have a short train-line. Make a service application of about 10 or 15 pounds then lap the valve and if the train-line hand slowly *raises* and driver or tender brake *release through the triple,* the rotary needs repairs. A leaky body gasket 61 F 6 valve or 32 G 6 valve will do the same thing. Main reservoir pressure passing into "Chamber D" thence through piston ring to train-line releasing the brake. Where the rotary leaks, it usually causes a blow at the train-line exhaust

where the gasket leaks the blow does not occur as Chamber D has the greatest pressure.

Defective Brake Handle Spring.—This is a portion of the engineers' valve to which no little importance is attached. Sometimes the spring becomes so weak that the engineer is not aware of where the handle is except by looking and, at night, feeling with the fingers. In addition to this it often becomes bent out of place by being violently pushed against the full release or full emergency stops. Then sometimes the bolt (that holds the spring to the brake handle) works loose. This bolt should always be tight and the spring or latch "rub the notches" heavy enough for you to know the position in which the valve is without looking or especially feeling.

D. 8 Brake Valve.—With this valve it must be remembered the pump is operated by the train-line pressure, and whenever that pressure is reduced, no matter from what cause, the pump will start to work. With the valve on lap any reduction in the train-line pressure will allow the pump to continue working until boiler pressure is obtained in the main reservoir. On this account if the brakes are required to be left applied for any length of time while the engine or train is standing the pump throttle should be partly closed.

Brake Valve Failing to Maintain Excess Pressure.—This defect is caused either by a leaky rotary valve or by dirt or gum on the seat of the excess pressure valve 21.

Excess With a Long Train but None with a Short.—With some brake valves it will be found impossible to get any excess with a lone engine or when coupled to a very short train; but when coupled to a long train, no trouble will be experienced. This latter action has often puzzled a great many. This action will occur when there is but a small leak under the rotary valve or past the excess-pressure valve, and is accounted for in this way: With the lone engine or but a few cars, the leakage from the train-line is usually small; if the leakage from the main reservoir under the rotary valve or excess-pressure valve is greater than the leaks in the train-line, the consequence will be, in a short time, to raise the pressure there equal to that of the main reservoir. But when coupled to a long train, there are generally more leaks, which usually being more than the valves leak in, the pressure there will not be raised and excess-pressure is maintained.

Leaky Excess-Pressure Valve.—If after being unable to obtain excess-pressure, you have tested for a leaky rotary valve and found that tight, it can reasonably be expected that the excess-pressure valve has accumulated gum or dirt on its seat, which comes from using a poor kind of oil or too much in the air cylinder of the pump.

To Take Out the Excess-Pressure Valve and Spring.—If there is no pressure in the brake system it is removed by simply screwing out the cap nut 19. But if the system is charged with air we must proceed a little differently, in which

se, close the cut-out cock in the train-pipe be-
ath the brake valve and place the brake handle
service position; as soon as all the air is dis-
arged from the equalizing reservoir screw off
e cap 19 (Figure 20) and remove the spring
d valve, clean or repair, but before returning
move the brake handle to running position
veral times for an instant in order to blow out
y loose dirt or scale that might be in the valve.
The object in closing the cut-out cock is to
ep all pressure in the train-line and auxiliaries,
om the brake valve; placing the handle of the
ake valve in service prevents main reservoir
essure from coming further than the top of the
lve. Placing the valve on lap would also ac-
mplish the same result, as far as the main
servoir pressure was concerned, but we would
ll have the 70 pounds' pressure in the equal-
ng reservoir to contend with; placing the valve
service position lets this escape. Don't fail to
ain open cut-out cock.

Too Much or Too Little Excess Pressure.—
ith the brake valve (D-8) when air is being
mped up with the brake handle in running
sition, the red or main reservoir gauge hand
ould start to move first, and raise about 20
unds before the black or train-line hand starts;
d remain 20 pounds apart. If the excess shows
ss than 20 pounds it is evident the spring is too
ort, or rather too weak, allowing the valve to
pen too soon. In this case the spring should be
aken out, and pulled apart and "stretched," so

brake valve, and when it is returned to running position the valve is practically "lapped" as the excess pressure valve will remain on its seat until the pump has raised main reservoir pressure 20 pounds in excess of that in the train-line. But before the pump can accomplish this the leaks in the train-line will cause the brakes to "creep on." The engineer now brings the brake handle again to full release and the few pounds of excess the pump has accumulated is thrown into the train-line, and although this may "pick off" the stuck brakes, the same trouble is again experienced when the brake handle is returned to running position as the valve is falsely lapped and the brakes again creep on. When releasing don't loose the 20 pounds excess, thus keeping the excess valve open to supply the train-line. (2) Another fault of the excess pressure valve is, the pump governor being connected to the train-line allows the pump to work until the boiler pressure is obtained, if the brake valve is left "lapped" too long. These result in the train-line and auxiliaries possibly being overcharged, the governor diaphragm is often ruined by the high pressure, and a burst hose frequently occurs. So do not leave the brake applied or the valve on Lap very long without nearly closing the pump throttle.

F-6 Brake Valve.—The material difference between this brake valve and the D-8 is very little except the substitution of the feed valve in place of the excess pressure valve. With the valve the

constitutes a part of the new valve.

ulating the Pressure with the F-6 Brake .—If the red or main reservoir gauge hand too high or too low pressure, it is the fault pump governor. (See Article, *To Regur Set the Governor.*) If the black or trainauge hand shows too high or too low pres- the feed valve needs regulating. (See folg article.)

Regulate Feed Valve Attachment.—If it the black hand or shuts off the train-line ure before it reaches 70 pounds, take off the ut 71 (Figure 22-A) on the bottom of the valve, and screw up the regulating nut 70 the train-line pressure stands at 70 pounds standard. If it allows too high a pres- n the train-line, slack off or screw down it 70.

en Feed Valve Fails to Maintain Train-Pressure.—With the brake handle in run- position, when the black hand or train-line

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F-6 Brake Valve.—The material difference between this brake valve and the D-8 is very little except the substitution of the feed valve in place of the excess pressure valve. With the valve the

than to oil and clean it occasionally. To clean the feed-valve while the system is charged with air, proceed as with the other forms of the Westinghouse brake valve.

Engineers' Brake Valve (New York).

The governor with the New York Brake Valve is operated by the train-line pressure and whenever that pressure is reduced, no matter from what cause, the pump will start to work.

Governor.—The range of variation of the time a valve will give good service without repair or attention is about the same as the Westinghouse valve. The New York valve, however, requires a little more frequent oiling, this being done by removing the oil plugs (96) (Figure 34) in the top of the valve casing and about three drops of good oil poured into each hole, the brake handle being moved to the opposite extreme position while the oil is being dropped in, so that it can reach the valve seat.

Brake Valve Works Hard.—This is mostly the result of the brake valve gumming on account of a poor oil or too much being used in the air end of the pump; this occurs, however, more frequently with a pump that is allowed to run hot. This difficulty can be overcome while on the road by draining all the air from the equipment and oiling through the plugs. Lubricate the handle shaft 120 through the hole *h* (Figure 33). The valve that requires frequent oiling in order to

70 pounds of train-line pressure to per
but when coupled to a long and leaky t
stops the train-line pressure at between
70 pounds. This is due to the gradual
action of the feed-valve which starts to cl
stricting the free flow of air through it wl
pressure reaches about 45 pounds, and co
to close gradually until 70 pounds' pres
reached, when it will close entirely. Thus
say, for example, when 65 pounds' pres
obtained in the train-line, the supply v
1/64 inch from its seat, and the amount
capable of getting through this opening
sufficient to compensate for the leakage
always encountered with a long train, it
very evident that the train-line pressure v
rise much above 65 pounds. When the
occurs the only way *to remedy* it is to
the regulating nut. This will allow 70 p
pressure to be obtained while coupled to tl
train, but as soon as a part or the w
"dropped" the train-line pressure will
about 75 pounds and must be lowered by s
ing the regulating nut again. This tro
overcome by the latest form of brake valve
as the

G-6 Slide-Valve Feed-Valve.—The lowe
tion of the valve is in construction and p
almost identically the same as the feed-v
the F-6 brake valve and is subject to the
portion of its defects. The slide-valve, o
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To Clean the Valve.—Remove the parts; fo eign matter and gum should be displaced b using a piece of waste saturated with kerosen Do not use anything hard to clean the valve se on account of liability of scratching it, and th causing a leak.

Brake Valve Failing to Automatically Lap.- The duty of the supplementary reservoir air to *automatically lap* the valve when maki service applications. If the valve does not c off properly in service application, look for lea age from the supplementary pressure to the a mosphere through the head gasket 167 (Figu 34), the piping to the supplementary reservo or the reservoir itself; the cause of this acti may also be traced to a leaky packing leather 1 or the ball check valve 184, the supplementary a passing over into the train-pipe instead of mo ing the piston 104 to close valve 110, thus e tirely or partly destroying the automatic featu and making it necessary for the engineer to l the valve with the brake handle, otherwise would continue to discharge from the train-pi pressure and the brakes apply in full.

Braking with Supplementary Reservoir Out Service.—If the supplementary reservoir or pi leading to it springs a leak, disconnect the pipe the brake valve union and plug the connection put in a blind gasket. Use the brake valve as l fore for service applications, but place the val on lap between reductions. It is not necessa

to use the emergency position for service braking under the above condition.

Brake Valve Failing to Maintain Excess Pressure.—This trouble is caused by either (1) A leaky main slide-valve or (2) by dirt or gum on seat of excess pressure valve 97 (Figure 39).

Excess with a Long Train but None with a Short.—See same subject for Westinghouse Valve.

Leaky Main Slide-Valve.—To Test: Use same method as explained in the subject *Leaky Rotary* for the Westinghouse Valve.

Leaky Excess Pressure Valve.—"To Test," "To take out the excess pressure valve or spring," "Too much or too little excess pressure" and *"When Train-Line pressure 'fluctuates.'"* See same subject as explained for the D-8 Westinghouse brake valve.

Train Pipe.

The train-pipe includes all the piping and hose used to convey air from the engineers' brake valve to the triples; including the pipes leading to the conductor's valve. The two principal troubles to which it is subject are *Leakage and Stoppage.*

Leakage.—Train-line leakage can best be detected, both if it exists and to what extent, by making a slight reduction or application of the brakes and then noting the rapidity of the fall of the train-line gauge hand. The places at which *leaks* are most likely to occur are: Hose couplings, in the hose itself, pipe unions, at the con-

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ductor's valves, at the T where the conductor's valve pipe is connected with the train-lines. (These are often caused to leak when the hose are allowed to be pulled apart by the cars, instead of being uncoupled by hand.) A leak in the auxiliary or its pipe connection or a bleed cock open or a blow from the triple exhaust will also show as a leak in the train-line, but will be treated under their respective heads: *Auxiliary Reservoir and Triple Valves.*

Leaky Hose Coupling.—The most frequent places of leakage are the hose couplings; generally caused by a defective rubber packing ring; oftentimes the rubber becomes pushed out of place or doubled over, and if straightened out and coupled over again it will not leak. Never strike the lugs of the coupling so as to make them go closer together, as the first time it is attempted to couple it to a car with the rubbers in proper condition, it will be too tight and cannot be united; also if the hose was not uncoupled by hand when the cars were parted, one of the hose would very likely be off. If the leak cannot be stopped by straightening out the packing rings drive a nail, a splinter of wood or anything between the coupling lugs to make a temporary repair.

Stoppage.—Under this head is meant any obstruction that will prevent the free flow of air through the pipes. The chief causes of "stoppage" are, (1) Hose cock closed. (2) Pipe frozen. (3) Drain cups filled with dirt, or (4) Portion of inside of hose or lining becoming loose and curl-

ing up into a ball. A hose cock might work shut while running over the road, from striking against overhanging load or the flopping of a loose pipe. Occasionally, but very seldom, a drain cup in the train-line will freeze up, but generally the "freeze up" has occurred before the hose was coupled up when it should have been drained or blown out. Drain cups have been found where the cylindrical screen has collapsed and with an accumulation of dirt has completely blocked the train-pipe. Air would leak through it just fast enough to charge up the auxiliaries in the rear of it after a long while, but air would not pass either way fast enough to allow the brakes to act. Stoppage can always be detected by the brakes working satisfactorily up to a certain car in the train, and beyond that car a complete refusal of the brakes to act, or they will be very slow to apply or release. These conditions of course will also cause the auxiliaries to charge very slowly. (In this connection see also what has been said on *"Triples Charge Auxiliaries Too Slow."*)

The Triple Valve (*Westinghouse and New York*).

About the first thing to learn (in the "doctor line") about triples, is that when they fail to act, it is seldom their fault. At least four cases out of five, when the brake fails to apply or release, the cause is not in the triple. But as it is the working of the triple that causes the brakes

to act, and it being the action of the brakes th is desired, and to which all other parts are alli it is naturally the index which shows by its a acting, that there is a defect somewhere; howe it may be very remote from the triple itself, b being visibly the part not acting it is natura blamed.

Care of the Triple.—Triple valves should n be allowed in service over six months with being thoroughly inspected and cleaned and t date of cleaning recorded on the auxiliary res voir. Kerosene is the best article to use. Af cleaning, the triple piston packing ring, the bu ing in which it works, and the slide-valve are t only parts that require oiling, and these ve sparingly. The emergency portions of the va should not be oiled at all, as their constructi does not require any; the oil will only gum a collect dust and dirt. The piston packing ri should be cleaned by working kerosene through without removing it from the piston (as by s doing it is liable to be sprung out of true). Whe triples are being cleaned the strainer in the trip and in the train-pipe T, where the branch pi couples on, should not be overlooked, but alwa thoroughly cleaned also.

Required Time to Charge Auxiliaries.—Air fed into the auxiliaries through the feed groo past the triple piston. The opening being of su a size when in *perfect condition* that the auxilia will charge from nothing to 70 pounds in abo 70 seconds, provided the train-line pressure is

70 pounds. No matter how many auxiliaries there are to be charged at once, they will all charge in about that time, *provided* the pump can keep the train-line pressure at 70 pounds; but this is impossible with more than a few cars. On account of the average condition of triple valves ordinarily a little longer, say ½ a pound per second, should be allowed for an auxiliary reservoir to charge.

Triples Charge Auxiliaries Too Slow.—In continuation of what has been said above, any conditions that will affect the size of the feed grooves will of course correspondingly affect the length of time it will require to charge the auxiliaries. When the feed groove becomes partly closed on account of dirt and gum, it will require a much longer time. But it is not always the feed groove alone that will cause an auxiliary to charge slowly, as any of the conditions explained under the heading "Stoppage" or existing in a less serious nature, will affect the time required to charge them. These latter conditions are largely due to the "what do I care" treatment received from indifferent trainmen. There are dummy couplings to hang up air hose when they are uncoupled, to prevent tearing off or damaging the coupling and filling with dirt and cinders. Before coupling hose together, trainmen should blow them out and see that no dirt or cinders have lodged in the coupling.

Engine and Tender Triple.—The plain triple shown on Figure 45, is now scarcely ever

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The Quick Action Triple.—Although the action in service application of the quick action triple is identical with that of the plain triple, both working in perfect harmony together, the addition of the emergency portion caused a number of defects not recorded against the plain triple.

Westinghouse: Blow at Quick Action Triple Exhaust.—When a blow occurs at the exhaust port of the quick action triple, other than the blow which occurs when the brake is intentionally released, it may be from a much greater variety of causes than the plain triple; and will be treated separately under the following heads: (It must be strictly remembered also that a blow at the retaining valve indicates "a blow at the exhaust" as the retaining valve is merely an addition, or "extension" of the triple exhaust.) Before going into any minute search, try the following and perhaps the blow will stop: Tap the triple lightly from three or four different directions; if this does not stop it, cut the brake out, bleed the auxiliary reservoir, and then open the cut-out cock to the triple quickly. If this fails try several emergency applications. If this does not stop the blow and you have a good number of air cars, and very little time cut the car out.

To Test for the Cause.—The first thing to be done to locate a blow from the exhaust (or pressure retaining valve) is to find out if it comes from the train-pipe side, or auxiliary-reservoir side of the triple. This can be determined by closing the cut-out cock in the train-pipe leading

to the triple. By so doing we bring about a natural action of affairs. If the leak is from the train-pipe side the brake will immediately apply. But if the leak is from the auxiliary side, instead of the brake setting, the blow will gradually grow fainter until all the pressure leaks away when it will stop. If the brake applies after you cut it out look for a leak in the following places, which will be treated separately in articles following: (1) Emergency Valve held from its seat. (2) Leaky Gasket 14. If the brake does not apply generally the leak will be caused by: (1) A Leaky Slide-Valve. (2) Leaky Gasket between Triple and Brake Head. And to the freight equipment may be added (3) Leaky Gasket 15, and (4) Leaky Pipe B through the auxiliary-reservoir.

Emergency Valve Held from Its Seat.—This is nearly always due to dirt or pipe scales becoming lodged under the seat, but occasionally the bearing face of the valve, which is of rubber, will be found to have rotted out or have become disarranged, holding the valve from its seat. When this valve leaks the blow will only occur while the triple is in release position, because when the slide-valve is in service position the exhaust port is closed, and the air that then leaks past the emergency valve goes directly into the brake cylinder. If this defect exists on a triple in a long train where the volume of train-line air is comparatively great, and the brake cylinder being in direct connection with it through the leak, it will equalize at such a high pressure, when a

light application is made, that the wheels on the cars will in all probability slide and be flattened. On occasions the brake will not release where this leak is extremely bad, but a strong heavy blow will start and continue at the exhaust when the other brakes are released. This occurs when the leak through the emergency valve is larger than the exhaust port—the air getting into the brake-cylinder faster than it can get out through the exhaust, thus holding on the brake. This will often occur after an emergency application. Tapping the triple, cutting out the brake and bleeding and then cutting in quickly or making several emergency applications will generally blow out the dirt and cause the valve to seat.

Leaky Gasket 14.—By carefully examining the illustration of the quick action triple (Figure 51), it will be noticed that the gasket referred to forms the joint that excludes the train-pipe air in passage *e* from the emergency chamber, which is always open to the brake-cylinder, and also the exhaust port, except when the brake is applied. When the gasket leaks at this point, the results following are identical with those when the leak is through the emergency valve, except that this defect cannot be remedied by tapping, etc.; neither does it occur as often as the other.

Leaky Slide Valve: See same subject for plain triple.

Leaky Gasket 15 between Triple and Brake-Head (See Figure 59).—The gasket between the triple valve and brake-cylinder, where they are

bolted together, sometimes becomes defective so as to allow auxiliary air to leak from the triple valve chamber at Y, direct into the brake cylinder passage X, thence through the exhaust. The blow will not occur while the brake is applied, but will cause the brake to release on light application in a short time, as it causes a reduction of air from the auxiliary to the brake cylinder. If the brake be fully applied, the auxiliary and brake cylinder pressures are equal, and the brake will remain applied.

Leaky Gasket 15 and Leaky Pipe B on Freight Equipment (See Figure 60).—Should the gasket 15 that forms the joint between the triple valve and auxiliary where they are bolted together, leak, it will cause exactly the same results as cited in last article; in fact, the leak is the same except that the triple is bolted to the auxiliary instead of the brake-head; but air leaks from the auxiliary into the brake-cylinder just the same, causing the brake to release when applied and a continual blow at the exhaust when in release position. When a leak occurs in the pipe B, the action will be the same as above.

Emergency Action When Not Wanted.—This is a very annoying defect and the faulty triple should be cut out at the first opportunity, as no attempt should be made to remedy it while on the road. The first thing to be done is to locate the offending triple. Remember that although all the brakes go into emergency, seldom more than one triple is found in fault. The faulty

make it work satisfactorily should be taken apart and thoroughly cleaned at the first opportunity.

To Clean the Valve.—Remove the parts; foreign matter and gum should be displaced by using a piece of waste saturated with kerosene. Do not use anything hard to clean the valve seat on account of liability of scratching it, and thus causing a leak.

Brake Valve Failing to Automatically Lap.—The duty of the supplementary reservoir air is to *automatically lap* the valve when making service applications. If the valve does not cut off properly in service application, look for leakage from the supplementary pressure to the atmosphere through the head gasket 167 (Figure 34), the piping to the supplementary reservoir, or the reservoir itself; the cause of this action may also be traced to a leaky packing leather 107 or the ball check valve 184, the supplementary air passing over into the train-pipe instead of moving the piston 104 to close valve 110, thus entirely or partly destroying the automatic feature and making it necessary for the engineer to lap the valve with the brake handle, otherwise it would continue to discharge from the train-pipe pressure and the brakes apply in full.

Braking with Supplementary Reservoir Out of Service.—If the supplementary reservoir or pipe leading to it springs a leak, disconnect the pipe at the brake valve union and plug the connection or put in a blind gasket. Use the brake valve as before for service applications, but place the valve on lap between reductions. It is not necessary

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The Quick Action Triple.—Although the action in service application of the quick action triple is identical with that of the plain triple, both working in perfect harmony together, the addition of the emergency portion caused a number of defects not recorded against the plain triple.

Westinghouse: Blow at Quick Action Triple Exhaust.—When a blow occurs at the exhaust port of the quick action triple, other than the blow which occurs when the brake is intentionally released, it may be from a much greater variety of causes than the plain triple; and will be treated separately under the following heads: (It must be strictly remembered also that a blow at the retaining valve indicates "a blow at the exhaust" as the retaining valve is merely an addition, or "extension" of the triple exhaust.) Before going into any minute search, try the following and perhaps the blow will stop: Tap the triple lightly from three or four different directions; if this does not stop it, cut the brake out, bleed the auxiliary reservoir, and then open the cut-out cock to the triple quickly. If this fails try several emergency applications. If this does not stop the blow and you have a good number of air cars, and very little time cut the car out.

To Test for the Cause.—The first thing to be done to locate a blow from the exhaust (or pressure retaining valve) is to find out if it comes from the train-pipe side, or auxiliary-reservoir side of the triple. This can be determined by closing the cut-out cock in the train-pipe leading

to the triple. By so doing we bring about a natural action of affairs. If the leak is from the train-pipe side the brake will immediately apply. But if the leak is from the auxiliary side, instead of the brake setting, the blow will gradually grow fainter until all the pressure leaks away when it will stop. If the brake applies after you cut it out look for a leak in the following places, which will be treated separately in articles following: (1) Emergency Valve held from its seat. (2) Leaky Gasket 14. If the brake does not apply generally the leak will be caused by: (1) A Leaky Slide-Valve. (2) Leaky Gasket between Triple and Brake Head. And to the freight equipment may be added (3) Leaky Gasket 15, and (4) Leaky Pipe B through the auxiliary-reservoir.

Emergency Valve Held from Its Seat.—This is nearly always due to dirt or pipe scales becoming lodged under the seat, but occasionally the bearing face of the valve, which is of rubber, will be found to have rotted out or have become disarranged, holding the valve from its seat. When this valve leaks the blow will only occur while the triple is in release position, because when the slide-valve is in service position the exhaust port is closed, and the air that then leaks past the emergency valve goes directly into the brake cylinder. If this defect exists on a triple in a long train where the volume of train-line air is comparatively great, and the brake cylinder being in direct connection with it through the leak, it will equalize at such a high pressure, when a

light application is made, that the wheels on the cars will in all probability slide and be flattened. On occasions the brake will not release where this leak is extremely bad, but a strong heavy blow will start and continue at the exhaust when the other brakes are released. This occurs when the leak through the emergency valve is larger than the exhaust port—the air getting into the brake-cylinder faster than it can get out through the exhaust, thus holding on the brake. This will often occur after an emergency application. Tapping the triple, cutting out the brake and bleeding and then cutting in quickly or making several emergency applications will generally blow out the dirt and cause the valve to seat.

Leaky Gasket 14.—By carefully examining the illustration of the quick action triple (Figure 51), it will be noticed that the gasket referred to forms the joint that excludes the train-pipe air in passage *e* from the emergency chamber, which is always open to the brake-cylinder, and also the exhaust port, except when the brake is applied. When the gasket leaks at this point, the results following are identical with those when the leak is through the emergency valve, except that this defect cannot be remedied by tapping, etc. neither does it occur as often as the other.

Leaky Slide Valve: See same subject for plain triple.

Leaky Gasket 15 between Triple and Brake Head (See Figure 59).—The gasket between the triple valve and brake-cylinder, where they ar

bolted together, sometimes becomes defective so as to allow auxiliary air to leak from the triple valve chamber at Y, direct into the brake cylinder passage X, thence through the exhaust. The blow will not occur while the brake is applied, but will cause the brake to release on light application in a short time, as it causes a reduction of air from the auxiliary to the brake cylinder. If the brake be fully applied, the auxiliary and brake cylinder pressures are equal, and the brake will remain applied.

Leaky Gasket 15 and Leaky Pipe B on Freight Equipment (See Figure 60).—Should the gasket 15 that forms the joint between the triple valve and auxiliary where they are bolted together, leak, it will cause exactly the same results as cited in last article; in fact, the leak is the same except that the triple is bolted to the auxiliary instead of the brake-head; but air leaks from the auxiliary into the brake-cylinder just the same, causing the brake to release when applied and a continual blow at the exhaust when in release position. When a leak occurs in the pipe B, the action will be the same as above.

Emergency Action When Not Wanted.—This is a very annoying defect and the faulty triple should be cut out at the first opportunity, as no attempt should be made to remedy it while on the road. The first thing to be done is to locate the offending triple. Remember that although all the brakes go into emergency, seldom more than one triple is found in fault. The faulty

light application is made, that the wheels on the cars will in all probability slide and be flattened. On occasions the brake will not release where this leak is extremely bad, but a strong heavy blow will start and continue at the exhaust when the other brakes are released. This occurs when the leak through the emergency valve is larger than the exhaust port—the air getting into the brake-cylinder faster than it can get out through the exhaust, thus holding on the brake. This will often occur after an emergency application. Tapping the triple, cutting out the brake and bleeding and then cutting in quickly or making several emergency applications will generally blow out the dirt and cause the valve to seat.

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Emergency Action When Not Wanted.—This is a very annoying defect and the faulty triple should be cut out at the first opportunity, as no attempt should be made to remedy it while on the road. The first thing to be done is to locate the offending triple. Remember that although all the brakes go into emergency, seldom more than one triple is found in fault. The faulty

one will usually be the last to act and the first to go into emergency.

To Locate.—One method is to set about five pounds in service application and then find out which cars having the quick action triple valve are not set; have some one watch each car while increasing three to five pounds more in the service application. The car that sets in quick action first is the defective one, but as emergency travels at the rate of about twenty-three cars per second, it is best to cut out one of the cars that did not set at the first reduction, and have the application continued; if this is proved not to have been the one thus defective, test the train again, cutting out another car that failed on the first application, until the defective car is located. Another and ordinarily shorter method is as follows: Cut the air cars into two equal sections and repeat the test for trying brakes. This will tell which half of the train is defective. Then take one-quarter or three-quarters, according to whether the defective car is in the front half or back half of the train and continue in this way (never trying with less than three car lengths of piping), until the defective car is found and cut out. Now a word about why the triple acts this way, and the different defects causing it, will be taken up in detail. In the first place we must remember what causes the emergency action of the triple, which is anything that will allow the slide valve to be drawn too far, so that air pressure gets on top of piston 8 (Figure 54).

fective Graduating Spring.—The graduat-
spring 22 (Figure 54) is put there for the
ose of stopping the piston 4 in ordinary
ce reductions, but we will suppose this
ıg has become weakened or broken, what
the piston from traveling too far? Nothing.
t is the result upon the first application?
rgency. This is then where the trouble is
you get emergency upon the first reduction,
ur train is short. If your train is long, how-
you will have no trouble from a weak grad-
ıg spring, and on a long train, if reductions
ıot made too heavy, you will have no trouble
with a broken one, or if it was missing alto-
ır. This may appear a little puzzling at first
ght, but upon second it becomes perfectly
. When a reduction is made on a long train,
lischarged from the train pipe must pass
ıgh the same sized opening it does on a
one; viz., the train pipe exhaust in the
e-valve. With 40 cars we have approx-
ely ten times the amount of air that must
through this opening to make a given reduc-
than we would have to make the same reduc-
on four cars; it will consequently require
ıger time. This causes a very gradual re-
on of the train line pressure in a long train,
since the auxiliary pressure begins to dis-
ge into the brake-cylinder as soon as port
the slide valve is above port *r* in the seat,
iary pressure reduces just as fast as does
ressure in the train line; thus, as there is

no greater pressure to force the triple piston any further, emergency action does not occur. On a short train the train-pipe exhaust reduces the train-pipe air somewhat faster than the auxiliary air can flow to the brake cylinder, the auxiliary pressure becomes enough greater than the train-pipe pressure to enable it to overcome a weak graduating spring, the piston assuming emergency position. This of course applies the others in quick action also.*

Sticky Triples.—When a triple "sticks" or is held in release position until the pressure on the train-pipe side is reduced low enough, so that the pressure on the auxiliary side finally forces it loose, it generally "lets loose in a hurry," striking the graduating spring 22 with force, compressing it, thus causing an emergency application of that brake, which in turn applies the others. When a triple "sticks," it will seldom act with the first reduction of 3 or 5 pounds, but when the pressure becomes great enough at the auxiliary side, it forces it loose with the result explained. The cause of a triple sticking is generally due to a tight fitting packing ring, lack of lubrication or dirty triple piston or slide valve, which is overcome by cleaning and oiling.

Broken Graduating Pin.—When the pin that fastens the graduating valve 7 to the stem of the triple piston is broken, it will cause a triple to apply "emergency." However, when the usual service reduction is made, the triple will assume service position, but on account of the graduat-

* (See *"Emergency Application"* Westinghouse or N. Y. Triple Valve.)

ing-pin being broken, there is nothing to move the graduating-valve from its seat, consequently no air passes from the auxiliary-reservoir to the brake-cylinder, until the pressure in the train-line has been sufficiently reduced, allowing the auxiliary pressure to compress the graduating spring 22 (Figure 54), forcing the valve into emergency position. With this defect it will be seen the brake will not act when the first reduction of perhaps 3 pounds is made, and can be detected with a light reduction by its not setting, and, when it does set, it will be in emergency.

Graduating Valve or Port Gummed Up.—When the graduating valve (7) (Figure 54) becomes badly gummed up, so that very little auxiliary air can get past it, the action of the triple will be about the same as if a graduating pin was broken.

Other Defects of the Triple.—Besides the defects already enumerated under particular headings, the following are defects to which the triple is subject:

Leaky Graduating Valve.—When dirt or scale becomes lodged on the seat of the graduating valve (7) (Figure 54), so as to cause it to leak air into the passage *z*, it will do no harm as long as the valve is in release position, whether the valve is open or shut; air cannot get further in the passage *z* than the valve-seat. But when the brake is applied the valve, being in service position, air will leak from the auxiliary through the ports *z* and *r* directly into the brake cylinder

This will result in one of two opposite effects, depending upon the extent of the leak and the tightness of the triple piston packing ring. If this ring does not make an air-tight joint and train-pipe air can leak past it into the auxiliary as fast as the latter pressure leaks into the brake-cylinder, the brake will gradually set harder. But should the packing ring be tight, air leaking from the auxiliary will reduce the pressure there to an amount less than the train-pipe and release the brake, unless the brakes were fully applied (auxiliary and brake cylinder equalized) before it has time to let off.

Triple Frozen Up.—This generally occurs on either the engine and tender or on cars that have been regularly drawn next the engine, as for instance the baggage car on a passenger train. When air-testing plants and locomotive equipment are properly arranged and well drained, seldom will we be troubled with frozen triples. When a triple does freeze up, it must be thawed out with a torch or a piece of waste saturated with oil on the end of the packing iron, the drain plug taken out and the water permitted to run out. This latter act is very often left undone after thawing out the triple, with the result that before the equipment goes far, the weather being cold, the triple will again freeze.

Defective Triple Piston Packing Ring.—A badly worn, damaged, or broken packing ring (5) (Figure 53 or 57) may produce either one of two opposite effects, while braking on a long train,

where the reduction and increase in train-pipe pressure is generally slow. It may either not apply the brake at all or may not release after applying. When the reduction in the train-line is slow, auxiliary pressure will leak into the train-pipe past the defective ring fast enough to keep the two pressures about equal, so there will be nothing to move the triple-piston and slide-valve, the brake will not apply. However, should the reduction in the train-pipe be faster than the auxiliary air could leak past the piston, the latter would be moved to application position. When the train-pipe air has been reduced with an over reduction below the equalizing point of the auxiliary and brake cylinder, this same leaky packing ring will allow the air, from the auxiliary reservoir and brake-cylinder, to flow into the train-pipe, thus weakening the braking power. This tendency, however, is overcome by the piston making a joint on the leather gasket 23, as shown in Figure 54. When releasing the brakes, if train-line pressure is increased slowly, it will feed by the leaky packing ring sufficiently fast to charge the auxiliary and leave the piston in application position.

Note: A packing ring is considered to be all right, if the triple releases when the train pipe air is increased in pressure at the rate of 10 pounds per minute, the brake having been applied service or emergency and a pressure of 60 pounds being held in the auxiliary at the beginning of the test.

Leaky Triple Check-Valve.—The check-valve 15 (Figure 53) is placed in the triple-valve to

prevent a backward flow of air from the brake-cylinder to the train-pipe in the event of a burst hose, train parting, an emergency application being made, or at any time when the train-pipe pressure is less than that in the brake-cylinder. If the check-valve were not in the triple, or it leaks, the braking power will be reduced by the brake-cylinder air passing into the train-pipe. This valve should be carefully ground in.

New York: Blow at Quick Action Triple-Exhaust.—If the blow of air occurs at the exhaust port of the New York quick-action triple (see plate Q6 Appendix, or Figure 55) other than should take place when the brake releases, it will be found to come from one or all of the following places: (1) *Leaky Exhaust Valve,* or (2) Leaky Graduating valve, both of which act similar to same defects explained under the same heads for the *New York Plain Triple,* (3) *Leaky Gasket 15 Between Triple and Brake-Head,* or (4) *Leaky Gasket 15 and Leaky Pipe on Freight Equipment.* For the two latter see the same subjects under head of "*Westinghouse Quick-Action Triple.*"

Blow at Port J (Figure 55).—A blow at port J may come from (1) the rubber seat of vent valve 71, (2) the rubber seat of emergency valve 138, or (3) the check-valve 117.

Vent Valve 71 Leaking (Figure 55).—This is usually due to dirt or scale becoming lodged under the seat. The seat, being rubber, may have rotted out. When this valve leaks it wastes

rain-pipe air, consequently if the branch-pipe cut-out be closed the brake will immediately apply.

Emergency Valve 138 Leaking (Figure 55).—The seat of this valve is also rubber, but less subject to leakage. When this leak does occur, auxiliary air will pass to chamber L, passing by the stem of piston 137 to the atmosphere through port J. Where valve 138 leaks badly, the auxiliary reservoir will not charge, consequently the brake cannot be applied. If it leaks a small amount the brake can be applied, but it will release, as the auxiliary air would leak down below the train-pipe pressure. Where valve 138 leaks badly it will also cause a blow through the triple-exhaust, as check valve 117 would be lifted off its seat as the auxiliary air, leaking into chamber L, could not flow rapidly, by the stem of piston 137.

Check Valve 117 Leaking (Figure 55).—This defect will cause a blow at port J only when the brake is applied, its effect being to gradually allow the brake to leak off.

To Remedy These Troubles.—Tap the nuts 141, 119 and cap 126 lightly. These failing, cut out the brake, bleed the auxiliary reservoir and remove nut 141 or cap 126, as the case may require, and clean the seats if dirty or renew them if worn out. To clean the check-valve 117, release the brake and unscrew nut 119, removing the valve without bleeding the auxiliary or cutting out the brake.

Quick Action When Not Wanted.—This trouble

may be traced to a weak vent-valve spring 132, the small port F in the vent-piston 129 being filled up with gum or dirt or to the packing of the vent-piston fitting its cylinder too tightly.

"Sticky" Triple.—In addition to the above, a "sticky" triple will sometimes cause the brake to apply quick action during a gradual train-pipe reduction. Generally when a triple sticks, it does not respond to the first reduction, and the brake does not set; with the next reduction the difference in pressure between the train-pipe and auxiliary is such that the triple-piston is loosened and caused to move to emergency position, the stem 129 (Figure 55) strikes with sufficient force to compress spring 132 and open the vent-valve 71; thus causing an emergency application of the brake on that car, while the application of the brakes in the train will be increased, also.

To Locate.—Proceed as described on the same subject for the Westinghouse quick-action triple, with the addition that when a sticky New York triple gives trouble, it may also be detected by the flash of air from port J, while the brake-piston moves out quickly.

Quick Action Fails to Apply.—Should the triple fail to apply quick action when wanted, the packing-ring, of vent-valve piston 129 (Figure 55) is a poor fit or badly worn, thus allowing chamber G air to pass back into the train-pipe without moving the vent-piston.

Other Defects.—The New York Quick Action triple is subject to the *"Leaky Graduating*

Valve," "Triple Frozen" and *"Defective Triple Piston-Packing Ring,"* all of which act similar to the same defect described under head of *Westinghouse Quick-Action Triple.*

Auxiliary-Reservoir (Westinghouse and New York.)

The auxiliary reservoir is "such a plain piece of machinery" that many may wonder what there is to get out of order about it. True, it is not subject to many defects, but those to which it is subject will seriously affect the working of that particular brake; the triple, however, mostly getting the blame for the trouble.

Brake Will Not Apply.—In nine cases out of ten when the triple refuses to set the brake, or the brake releases immediately after setting, it is the result of a leak in the auxiliary reservoir air, which is the source of power for that particular brake. Again, the auxiliary pressure will only keep the brake applied as long as its pressure is not reduced below that in the train line. When these two facts are clearly understood, the triple will receive less blame for not "acting" properly. In looking for a leak in the auxiliary-reservoir air it must be remembered that any leak beyond the triple-piston must be considered a leak in the auxiliary reservoir, whether the leak be into the brake-cylinder and thence through the triple-exhaust, or direct to the atmosphere through the feed-valve or the gasket 15 (Figure 59 or 60),

which makes a joint between the triple-valve ar auxiliary.

Brake Cylinder (Westinghouse and New York —The brake cylinder being the place where th power (air pressure) is admitted to apply th brake, it must be kept there as long as it desired the brake should be held on, or the enti remaining portion of the brake system will l for naught. In order that it can be kept ther the cylinder must be tight, and free from leak Again, after the triple-valve has released the ai from it, the piston must return to its norma position, or the brake will remain applied, an it will have again failed in its duty. Its tw principal defects are (1) leakage and (2 "sticking."

Brakes Don't Hold.—When a brake "lets go after it has once set, without a blow at the triple exhaust, and the piston travel is not too shor so as to prevent the piston traveling beyond th leakage groove, it will be very evident that air i escaping from the brake-cylinder, due to

Leakage.—Leakage from the brake-cylinde will be mostly found to occur (1) past the leathe packing 7, either from the leather becoming badl worn or imperfect fit, or on account of becomin dry for want of oil; (2) or a leak may occur o account of the follower plate-bolts 5 (Figur 60) becoming loose. In the event of a leak occu ring at any of these two places, it will cause blow at the vent-hole when the brake is applie (3) A leak will sometimes occur at the gasket 1

that forms the joint of the cylinder-head. This can generally be stopped by tightening up the nuts. With the engine-driver brakes the leather packing will give a great deal more trouble by drying out than car leathers, on account of the heat of the fire-box.

Brakes Sticking After Triple Has Released.—After the triple has released the air from the brake cylinder, and the piston still remains out or "stuck," it will most generally be found to be due to (1) *Lack of oil in the brake-cylinder;* (2) frequently it will be found due to a weak or broken release spring (9) (Figure 60); (3) occasionally it is due to sleeve-piston 3 being badly corroded, so that it will bind or stick where it passes through the cylinder-head. This last cause can very easily be remedied while on the road by oiling the piston-sleeve. For the other defects it will be best to cut the brake out, if it gives frequent trouble.

Lack of Oil in Brake Cylinder.—When the cylinder and packing leather becomes dry or gumming from lack of cleaning, the brake-piston is liable to bind and not return to normal position, but will hold the brake-shoes against the wheels, making it necessary to pry the piston back with a bar in order to release the brake. This can only be remedied by taking off the piston-head and cleaning and oiling the cylinder and packing-leather.

Weak or Broken Spring.—When the release spring 9 becomes weak or broken, the same result

will follow as cited in the last article. To repai the spring must be strengthened or renewed.

Piston Sleeve Split.—Sometimes the brak rigging is put up so that, instead of the pist moving straight out and in, or nearly so, it wor continually heavy against one side. This in tir will wear the sleeve through, which then expanc and prevents the release-spring from forcing t brake-piston to release position and the brak will remain set. In this case the sleeve must renewed.

Retaining Valve (Westinghouse and New York

Before any defects of the retainer can clearly understood, it must be known that the r tainer is for no other use, and performs no oth duty when cut into service, than to prevent a the air escaping from the brake-cylinder wh the brake is released. Thus, it can only be su ject to two defects; which, however, may occ in many different places: (1) Leakage which w allow the pressure to escape when it should retained, and (2) stoppage which will not allc the pressure to escape when it is desired should. The pipe leading from the triple-exhau to the retaining-valve must be considered a pa of the "retainer," since if this pipe leaks or burst, it connects into nothing but a bursted pi with a retaining valve on the end of it, no matt how perfect the valve may be, it will n "retain"

Leakage.—This is by far the most common defect of the retainer, and, as has been said before, will render it useless. At the following places a leak is most likely to occur: (1) At the plug cock 6 (Figure 66), which may be the result of the plug or the seat being cut, or the plug becoming too loose, allowing the air to leak around it, thence out of the port *e* to the atmosphere; (2) dirt on the seat of the weight-valve 20; (3) the pipe leading from the triple to the retaining valve may be burst; or, (4) leak at the union in this pipe near the triple-pipe; or, (5) a leak may occur at the seat of the weight-valve 20, if the retaining valve becomes displaced from a perpendicular position.

Stoppage.—Any obstruction in the retaining-valve or pipe, which will prevent the escape of air from the brake-cylinder will keep that brake set, and after several applications of the brake, it will be set hard enough to slide the wheels. On account of the air being unable to escape, each time the brake is released, when applied, the auxiliary and brake-cylinder equalize at a higher pressure. Any obstruction will generally be found in the retaining-valve. In cold or rainy weather, in winter, sometimes the discharge port *e* will freeze up. This will be found to be a frequent cause of stoppage.

Blowing.—When there occurs a continual blow at the retaining valve, it is no fault of it whatever. The trouble is in the triple. Anything that

causes a blow at the triple-exhaust will cause the retainer to blow. Do not plug up the retainer.

Automatic Slack Adjuster (Figures 67, 68).

The slack adjuster was designed to overcome one of the greatest irregularities of the air-brake, i. e., piston travel. About the only defect we should expect of the adjuster would be

Failing to Take Up the Slack.—Under this head we might find, (1) the air-pipe (Fig. 67) *b* stopped up. This would prevent the air from entering the adjuster cylinder when the brake-piston traveled far enough to open port *a*. If the air-pipe should become broken a blind gasket should be inserted till repairs can be made; (2) the packing leather 19 (Figure 68) of the adjuster cylinder becoming dry and leaking, thus allowing the air to pass the piston instead of pushing it out to perform its duty; (3) the screw and ratchet-wheel becoming clogged so that, when the air is released, the spring 21 is not able to turn the ratchet-wheel and take up the slack.

Adjuster Becoming Locked.—This is liable to occur when the brake-shoes become so badly worn that the adjuster takes up slack till it pulls its cross-head against the adjuster-frame, thus preventing the pawl from disengaging. The later styles of adjusters have a stop-pin in the adjuster-frame, or a tap-bolt in the end of the sleeve of the adjuster-wheel, against which the adjuster crosshead strikes.

To Unlock.—Should the adjuster thus become locked, the stop-pin can be removed, and the pawl disengaged. In the older form of adjusters the stop-screw was omitted, and in order to unlock the pawl it was necessary to remove the bolts in the ratchet casing, so that the pawl could be disengaged.

Care of the Adjuster.—About the only care the adjuster needs is cleaning and oiling when the brake is receiving like attention. No oil whatever should be placed on the screw or ratchet-wheel, as it collects dust which forms gum and causes the wheel to turn hard on the screw. When the adjuster is cleaned, fill the sleeve of the ratchet-wheel about half full of dry graphite to lubricate the screw; this will last till the next time the adjuster receives its regular cleaning.

Letting Out Slack.—Since the duty of the adjuster is to take up slack as the brake-shoes wear, it necessarily follows that the brake-rigging should be let out at the adjuster when new shoes are applied. Letting out four full turns of the ratchet-wheel for each new brake-shoe applied is a good rule to go by.

To Test.—Let out enough slack in the brake-rigging so that when the brake is applied, the brake-piston will move out past port *a* (Figure 67), thus admitting air through pipe *b* to the adjuster. Leakage of the air-pipe or adjuster packing-leather, can be easily detected. Next release the brake and note if the ratchet-wheel is turned on the adjuster-screw by the return of the

adjuster-piston, when the brake is released. After the adjuster is tested and found all right take up the brake-rigging slack so that piston travel will be 6½ inches standing test.

Air Signal System (Westinghouse and New York.)

As the air-signal system does not comprise many parts it is not subject to many diseases. But as it is the "telephone" of the conductor to the engineer, it is very important that the signals given be correctly transmitted. The first thing to do when a complaint has been made that signals do not reach the engine in the way intended, is to find out if they are properly given. Always first be sure the signal system is out of order before giving it medicine.

How to Give Signals.—As has been intimated above, signals are so often improperly given that a few words as to how they should be, will not be out of order. When a blast of the whistle is to be made, the car discharge-valve should be pulled wide open, and held so about one second. Then the discharge valve should be allowed to remain closed until the pressure has again equalized, which, depending upon the length of train, will vary from 2 to 3 seconds, which should be allowed between each blast. Two, three, or four blasts of the car discharge-valve in quick succession on a long train will result in one long blow of the whistle on the engine. Trainmen are often

liable to hold the discharge valve open too long, and then not allow sufficient time to elapse for the air to equalize before making another blast. Always remember it is not the amount of air that is let out of the signal line, but how quickly it is done that causes the whistle to blow.

No Air from Discharge Valve.—When no air escapes from the discharge-valve when it is opened, of course the whistle will not blow. This may be due to (1) the cut-out cock that is usually placed in the discharge-valve pipe being closed; (2) or a signal hose-cock between that car and the engine may be closed. (3) If in cold weather, the signal-pipe may be frozen up. This is most liable to occur in the hose between the engine and tender. (4) Or a bad leak in the signal system will let the air out as fast as it is able to get by the reducing valve. This last fault, however, will generally be indicated by a faint blow at the discharge-valve when it is opened.

Whistle Fails to Blow (Westinghouse).—If there is a blast of air from the discharge valve when it is opened, but the whistle fails to blow, it may be due to one or more of a number of causes: (1) The air passage *e*, in the signal-valve (see Figure 69) that admits air to the whistle may be stopped up; this will prevent air from reaching the whistle. (2) The strainer in the tee where the branch-pipe to the car discharge-valve connects to the signal-pipe may be badly filled up with dirt, so as to prevent the air in signal-line getting through fast enough to make

a sufficiently rapid reduction to operate the signal-valve. Air may be able to get through the strainer so as to fully charge the signal line, but it has probably required considerable time to do it. *To Test* for this, close both hose-cocks between the head car and tender, disconnect the hose and make a reduction in the signal-line by opening the cock a small amount. If the whistle blows all right, with a slight reduction, the trouble is not on the engine. (3) If the whistle, however, fails to blow, it may be that the small port *d* in the signal-valve is stopped up with dirt, preventing air from getting to the signal-valve. (4) The stem 10 of the signal-valve may have become so loose in the bushing 9 as to let the air pressure in chamber B reduce as fast as the pressure is reduced in chamber A. This occurs in consequence of the air passing by the stem into passage *c* and into chamber A, and permits both to reduce together, in which event the stem 10 does not rise and no air is admitted to passage *e* which connects with the whistle. (5) Approximately the same action results if the signal-valve diaphragm 12 becomes cracked or leaks; or if it becomes loose so that it "bags," the whistle will not blow, as the diaphragm will fill Chamber A without raising the stem 10. *To Locate and Remedy* the last three defects, it will be necessary to take the signal-valve apart. Before doing so, however, be sure that the trouble is not in the whistle itself. (6) If the bowl of the whistle becomes filled with

dirt, or the bell is improperly adjusted, it will not blow. *To Test.*—If the trouble is in the signal-valve or whistle, have some one make a reduction in the signal-line and carefully note if any air comes out of the whistle. If no air appears there, look elsewhere for the trouble.

(*New York*) *The New York whistle failing to blow* will be from almost the identical defects that prevented the Westinghouse from blowing; excepting that stem 10 (Figure 69) does not extend downward through the diaphragm into chamber B; thus there is no defect from air leaking past it into chamber B, as explained for the fourth cause of the Westinghouse whistle not blowing in preceding article.

Whistle Blows When Not Wanted.—This trouble may present itself in several different ways, and the defect is located according to the manner in which the whistle blows. A continuous blow of the whistle is caused by dirt becoming lodged on the seat of the stem 10, of the Westinghouse (Figure 69), where it enters the bushing 7; if the New York, where it closes the passage *e*, which is connected directly with the whistle, thus causing the whistle to blow continually.

If the Whistle Blows When Brakes Are Released, it is a sure indication that you have main reservoir pressure in your signal line, instead of 0 pounds, the usual standard. This is due to ome fault in the reducing valve. (See Plates 33 and A3 Appendix.) If an old-style Westing-

house or a New York reducing valve, it will generally be found due to a weak or broken spring 10, allowing supply valve 5 to remain off its seat. If an improved reducing-valve, (1) the regulating nut 14 is screwed up too tight, causing the spring 13 to hold the valve 4 from its seat; (2) or dirt or scale may be on the seat of valve 4, holding it from its seat. The proper course to pursue is to first ease up on the regulating nut 14. If this does not reduce the pressure, the valve 4 must be taken out and its seat cleaned. To do this close the cock in the reducing-valve, which shuts off main reservoir pressure. Then close the hose-cock of the signal line behind the tender, if coupled to a train, and open the one on the front of the engine. There will then be no air pressure in the reducing-valve, and you have wasted very little. The reason the whistle blows when the signal line pressure is equal to the main reservoir, is that the reducing valve, being held open, establishes a direct passage between the main reservoir and the signal-line, so that the main reservoir becomes virtually a part of the signal-line. When the brakes are released, a reduction is made in the main reservoir, which causes the whistle to blow just the same as though the reduction had been made in the signal-line itself.

Whistle Makes One Long Blast or Several Short Ones (Westinghouse).—By this is meant that when several blasts of the car discharge-valve are made, instead of the whistle responding to each, it blows one long note. As has been said

fore, in nine cases out of ten, it will be found
ıe to the reductions having been made too close
gether. After you have convinced yourself, how-
er, that such was not the case, then the trouble
ıst be looked for in the signal-valve. If the
ım 10 (Figure 69) works stiffly in the bushing
it will require the pressure on each side of
ə diaphragm 12 to vary considerably, before it
moved. The stem 10, having the proper fit in
ə bushing 9, plays a very important part in the
ıke-up of the signal apparatus. If it fits too
ɔse, as explained before, the whistle will be
ely not to blow at all, and, when it does, will
ten make a number of short notes, closely con-
cted. This is caused by equalization between
ambers B and A, while the reduction is still
king place in the signal-line, causing it to
brate. Pressure on the top side of the dia-
ıragm is supposed to accumulate the faster. If
fits too tight; when it is once raised, it remains
) until the pressure on the upper side becomes
ɔnsiderably greater before it will seat again.
he small variations in pressure between car dis-
ıarge-valve blasts will not be sufficient to move

Whistle Makes One Long Blast or Several hort Ones (New York).—Little trouble has ɐn experienced in this respect with the New ɔrk signal-valve. The construction is different ıich is susceptible to different defects or ɔubles.

High-Speed Brake.

Since the advent of the high-speed brake, it has brought its care and attention. It must be understood that the extra parts are standard material used elsewhere in the air-brake equipment, with the exception of the *Westinghouse reducing* valve (Figure 73) and the *New York compensating* valve (Figure 81), the success of either depending upon their sensitiveness or freedom of action. These valves, being connected to the brake-cylinder and adjusted at 60 pounds, their irregularities influence the brake-cylinder air by either (1) leakage, (2) failure to blow down the over-pressure, or (3) not closing at the proper pressure.

Leakage, Westinghouse Reducing Valve.—All pipe-joints leading from the brake-cylinder to the reducing-valve should be tight; also the slide-valve 8 (Figure 73), and the leather washer 20, which makes a joint at *e* when the reducer is closed. This washer should also fit the cylinder neatly, the packing ring 5 should also be a neat fit.

New York Compensating Valve.—This valve has two pipe connections, both of which should be tight, particularly the one leading from the brake-cylinder, the leather washer H. S. 80 (Figure 83) should be a neat fit in the cylinder and make a joint on the upper side when the compensating valve should be closed. The leather washer H. S. 80, if cut a little too large in diam-

r, may partially reduce the annular space be-
en the piston and the bushing, tending to re-
ct the relief ports, and thus retard somewhat
escape of surplus air from the brake-
nder. Care should be had in renewing the
her washers to see that they are cut the
ct diameter of the top of the piston, or a little
, if anything. The upper metal packing ring
S. 81, covering the relief ports in the bush-
together with the leather washer, constitute
ouble control of the relief ports, making leak-
from the brake-cylinder almost impossible.
wever, should it ever be necessary to renew
upper packing ring, care should be taken in
ding it in to make it a practically air-tight
, so that when the valve starts to open, air
n the brake-cylinder cannot leak past it in
ssive quantities.

he lower metal packing ring H. S. 81, controls
leakage ports *b* (see Figure 82), and, like the
er ring, it should be a practically air-tight
since it forms the dividing line between the
ng-box chamber and the atmosphere. In
rgency applications, with the New York
k-action triple-valve, this ring should retain
air vented into the spring-box chamber, allow-
no leakage except as the vented air backs out
ugh the small port J, in the non-return check-
e, shown in Figure 81.

s the total travel of the piston is something
than the width of a single packing ring, when
piston is at its extreme lower traverse, the

leakage ports 6 come opposite the annular groove in the piston between the two packing rings and this groove, and the ports provide sufficient outlet for the air that may leak by the upper packing ring to get to the atmosphere. The leakage ports *b* do not influence the action of the valve perceptibly; they simply carry away the air that may leak past the upper metal packing ring, thus preventing it from getting down into the spring box chamber, under the piston. The gasket H. S. 90 (Figure 83) makes an air-tight joint between the body and the spring-box; the bolts that join these two sections together, therefore, should be drawn tight, so that there will be no leakage at this point from the spring-box chamber. The cap-nut H. S. 13 should make a tight joint on the body H. S. 76, also preventing any leak from chamber A.

Failing to Open and Blow Down Over Pressure (*Westinghouse Reducing Valve*).—The cause of this is usually found to be either the adjusting-spring set too high, the piston 4 and stem 6 binding in the cylinder and cap-nut, or the vent-port in the bottom of check-nut 13 becoming clogged, so that any air, leaking by the washer 20 would accumulate and help the adjusting spring 11 (Figure 83) to hold the piston up and the slide-valve closed. The exhaust port Y may become clogged, although a pipe-elbow screwed into it would prevent an accumulation. The strainer 17 (Figure 74) may also be clogged.

New York Compensating Valve.—Like the

Westinghouse Reducer, when it fails to blow down the over-pressure, it may be adjusted too high. The strainer 17 (Figure 80) may also be clogged; the piston and stem may be binding in the cylinder or cap-nut; or the vent port J of the non-return check G may be stopped up, thus preventing the reduction of any pressure that may accumulate in chamber A during emergency action.

Not Closing at the Proper Pressure (*Reducing or Compensating Valve*).—This particular action may be traced to the piston and stem binding in the cylinder or cap-nut, the adjusting spring set at too low tension or spring broken, or some obstruction may accumulate in the port openings or on the leather washer, thus interfering with the full return of the moving parts.

To Test and Adjust (*Reducing or Compensating Valve*).—Connect an air-gauge to the special tee in the brake-cylinder pipe, that the air pressure may be observed. Charge the equipment to at least 100 pounds pressure and apply the brake. The reducer or compensating valve should open at 62 or 63 pounds pressure service application and close at 60 pounds after a full service or emergency application. A change of adjustment may be accomplished by removing the check-nut and tightening or loosening the adjusting screw.

Cleaning and Oiling.—All parts of the high-speed brake should be cleaned and lubricated at least every three months, as the high-pressure

air has a greater tendency to wear off the lubrication than has the lower pressures.

Combined Automatic and Straight Air Brake.

(Figure 84 or Figure 91.)

About the only defects that need to be mentioned under this subject is the leakage of the valve-seats on account of dirt or gum, or the seats becoming worn.

Reducing Valve (*Westinghouse or New York*).—Should the seats of this valve leak, the straight air pressure will become greater than the desired amount, and possibly slide the wheels during the time the straight air is used to stop the engine. Usually cleaning the supply-valve or regrinding it, will overcome this trouble.

Straight Air-Brake Valve (*Westinghouse*).—Referring to Figure 88, if the seat of application valve 8 leaks, it will cause a blow through the exhaust opening of the brake-valve when it is on release position; if the straight air-brake is applied, valve 8 leaking will allow the brake to apply harder with the brake-handle on lap position. If release-valve 9 leaks, it will cause a blow through the exhaust when the brake is applied, and then it will allow the brake to release when the brake-handle is placed on lap position. Clean the valves or renew the leather seats; this can be done by removing the caps 12 or 13, as the case may require.

Straight Air-Brake Valve (*New York*).—Re-

ferring to Figure 93, if the slide-valve 227 leaks, it will cause a blow at the exhaust when the brake-handle is on release position. If the brake be applied lightly, it will usually apply the brake stronger, although it is possible to have the slide-valve leak only when the straight air-brake is applied; if such is the case, the brake-cylinder air will leak out through the exhaust during the application of the brake. The cure is usually to clean and oil the slide-valve and seat, or have them faced off and reground.

The Double Check-Valve.—Both Westinghouse and New York double check-valves have leather seats on the ends of the piston-valve. Referring to Figure 87, if the leather seat which makes a joint at *b* leaks, it will cause a blow, at the triple-valve exhaust, when applying the straight air-brake. If the leather seat which makes a joint at *a* leaks, a blow will occur at the straight air-brake valve exhaust when the automatic brake is applied. Clean or renew the troublesome seat. It can be easily removed by disconnecting union 8 and unscrewing cap 2.

The Safety Valve (*Westinghouse and New York*).—The safety valve, being connected to the brake-cylinder, will of course affect that pressure only when the brake is applied. Where the safety-valve leaks it is usually dirt under the seat, or it needs grinding in. A blow at the safety-valve may be caused by its being adjusted too low, or the reducing-valve may be adjusted too

high, so that it raises the brake-cylinder pressu above the blow-off point of the safety-valve.

To Test.—If the equipment has a permane air-gauge connected to show brake-cylinder pre sure, it can be used to test and adjust the redu ing-valve and safety-valves. Where the engine not so equipped, a test-gauge may be temporari used for such purpose by connecting it to t plugged opening at A or B, as in Figure 84.

To Adjust.—Set the reducing valve at pounds and the safety-valve at 53 pounds.

CHAPTER XXV.

HANDLING AND CARE OF THE AIR-BRAKE.

[aving thoroughly mastered the construction principle of action of the air-brake, the next) is to learn how to operate, care for and ıst it.

he articles appearing in this part will be ın up in rotation as they would naturally pre- themselves to the engineer from the time he ıs on his engine, following him through his re trip, and leaving him as he leaves his en- after the trip is made.

he Pump—Packing the Piston Rod.—The ıer time to pack the pump is before it is ted, as everything is then cool and the opera- is not so likely to be attended with burnt ers. Never allow your pump to blow. It not makes the pump deficient, but the steam and escaping tend to cut a channel in the piston- just as running water cuts away a rock. ; cutting may be so little that it cannot be ced with the naked eye, but the one who ers his pump to blow long at a time, always a blowing pump, and usually complains that 'cannot pack it so it will hold''; neither can one else after it is ruined. In packing do

...s do not let the air
...servoir as fast as it is
...piston, consequently it
...gh pressure at each end
...ssure means high tempera-
...60 degrees is compressed
...ure as follows, 70 pounds
... 105 pounds 490°.) It is
... pump is run at a medium
...s at each stroke to absorb
...nder temperature is not so
... speed gives the pump more
...eat. Now that your pump is
... its mission of compressing
...e some place to put it. You
...eservoir, but you are not sure
... it may be full of water. So

Reservoirs and Blow Out the
...ere are two important reasons
... the water is allowed to accumu-
...nto the air-brake equipment; in
...ey will freeze up and be entirely
... (2) You need all the space for
... air. Remember there is but one
... of the main drum,—as large as
...e sure to use all the room in it for
... air.

...ore Leaving the Engine House.—
...e governor stops the pump, the train-pipe
...e gauge should stand at 70 pounds and
...servoir at 90 pounds or more if ser-

uld be opened. Start the pump slowly at first il about 30 or 40 pounds of air are accumud for the pistons to cushion on, as there is no vision made in the steam end of the steam nder to bring the piston easily to rest, and sequently there is nothing to prevent it from ently striking the cylinder heads. Start the icator soon after you start the pump. After pump is warm, close the drain cocks, open the ıp throttle wide enough to run the pump at a lerate speed.

peed of Pump.—Do not adhere to an old rule un the pump as slowly as possible "just so as upply air enough"; this is wrong; the govor will attend to that in a better manner than can. Never run the pump slower than 90 le strokes a minute. Pumps that have been ervice a long time without overhauling will do er at 120 single strokes a minute. The speed be increased as occasion may demand but r faster than about 140 strokes a minute. ıer extreme will not give the best results. If the ıp is run too slowly, some of the air will have to leak past the packing rings into the other of the cylinder. This will cause it to coms less air per stroke, as it is heated by being urned" back and forth from one end of the ıder to the other, and taking the place of cold h air that would otherwise be drawn in. A ıp running too fast will heat because the reing valves do not permit a full cylinder of air e drawn in at the receiving end of each stroke.

Then the discharge valves do not let the air through into the main reservoir as fast as it is being compressed by the piston, consequently it is subjected to a very high pressure at each end of the stroke; high pressure means high temperature. (When free air at 60 degrees is compressed it will raise in temperature as follows, 70 pounds 400°, 90 pounds 450°, 105 pounds 490°.) It is plain to see that if the pump is run at a medium speed, cool air enters at each stroke to absorb the heat; the final cylinder temperature is not so high; also the slower speed gives the pump more time to radiate its heat. Now that your pump is properly started on its mission of compressing air, there must be some place to put it. You think in the main reservoir, but you are not sure there is room for it; it may be full of water. So the next step is to

Drain the Main Reservoirs and Blow Out the Train-Pipe.—There are two important reasons for this: (1) If the water is allowed to accumulate, it will get into the air-brake equipment; in cold weather they will freeze up and be entirely out of service. (2) You need all the space for the storage of air. Remember there is but one rule for the size of the main drum,—as large as possible. Be sure to use all the room in it for the storage of air.

The Test Before Leaving the Engine House.—When the governor stops the pump, the train-pipe hand of the gauge should stand at 70 pounds and the main reservoir at 90 pounds or more if serv-

ice demands, for high speed brake, train-line 110 pounds, main reservoir 120 to 130 pounds. Now make a 20 pound reduction and note if the brake sets; then, leaving the handle on "lap," shut off the pump and watch both hands of the gauge for a moment; if they remain stationary the brake valve, main reservoir and train-line are tight. Now note if the brakes have not released or leaked off. Then see that the driver brake pistons do not travel less than ⅓ or more than ⅔ of their stroke, and the tender and engine truck brake pistons do not travel less than six or more than eight inches. Then place the brake valve handle in "release" position and back to running position, noticing if brakes all release. If so the engine is ready to leave the round-house.

If you are to pull a passenger train, in addition to the above you should slightly open the hose cock of the whistle-line several times, closing quickly, in order to test the air signal whistle.

Coupled to a Passenger Train: The Terminal Test.—After being coupled to the train, do not test the train brakes until you have the full train-line pressure and the train is reasonably free from leaks. If there are no serious leaks, and a signal is given by the inspector or train crew to apply the brakes make a service application sufficient to produce a 20 to 25 pound train-pipe reduction. Lap the valve, leaving it there until the brakes are inspected and the signal is given to release. Be particular to see that the inspector gives the signal to release from the *rear* car, then

be made from the locomotive on trains to b backed from the yards, and afterwards fro the Back-up Hose by signaling to the enginee and then making the application; the engineer observe if a reduction is made as indicated by t black hand of the air gauge, and when such a r duction is made to signal to the rear end. T standard code of signals of the road in questi should be used. Only the Back-up Hose test described should be made on trains to be back from terminals when the make up of train ha not been changed at the terminal. (5) A runnin test with the Back-up Hose should be made, th first application being about 200 feet, or abou three coach lengths from the start, the engineman to stop if a slow down is not felt within this distance. (6) The handle of the engineer's brake valve should be carried in Running Position, and *not* placed on "Lap" to assist in making an application from the Back-up Hose. Following either a slow down or stop when signal is given to continue backing, the handle of the brake valve should be moved to "Release" position as in making a regular brake release (to be sure all brakes are released). On grades where a train will not stand with brakes released, it should be held by the *straight air brake* on the engine and tender, or, in the absence of such a brake, by admitting steam to the cylinders with engine reversed. The engineer should apply the automati brake, in the absence of a sufficient applicatio from the *back-up hose* whenever it is required t

insure the safety of the train.* (7) *Trainmen* should understand that to operate the brakes from the Back-up Hose, with the handle of the brake valve in "Running" position, the valve should be opened gradually; also that the opening should be gradually increased until the valve is either wide open, the train has slowed down as much as is desired, or has stopped. *It must not be opened and closed.* In case they have applied the brake too hard, closing the Back-up Hose will allow the brakes to release and recharge. The rapidity with which the valve should be opened will depend on the speed and length of the train and the distance there is to stop in. In case of emergency it should be opened wide, instantly.

Making a Water Plug Stop With Passenger Train.—Care should be exercised in making a water-tank or coal-chute stop. Many engineers do not go about it in the right way. They naturally choose the plug as the place they want to stop and don't care how (provided they accomplish their object). A better way is to use two applications, calculate stopping about 30 feet short, and then when the train has slowed down to about 2 or 3 miles an hour, throw the brake handle into full release and immediately return it to lap. Then when the tank hole comes nearly opposite plug, a very slight reduction will bring you to a stop at the right place without any unpleasant jar.

*The use of Running position is favored that full train pipe pressure may be maintained. It is not deemed necessary to "lap" the brake valve during brake application of the Back up Hose, as the brake will respond promptly from either position.

Steadying Fast Passenger Trains on Curves.—This should be done by a moderate application of the brakes to prevent the train from "Lurching" as the engine and cars strike the curve. To do this satisfactorily, make the application an engine length before striking the curve, allowing the brake to remain applied till the last car is on the curve, then release. It will not be necessary to hold the brake on clear around the curve as the "lurch" is over as soon as the flanges of the wheels crowd the outside rail.

Coupling to Freight Train.—When coupling to a train that is already charged, always leave the brake handle in running position. But before coupling to a long train that is not charged, it is a good plan to make several heavy applications of the engine and tender brakes and then leave the brake valve on "lap" until the engine is coupled to the train. Unless you do so, the flow of air back into the train will apply the engine and tender brakes so that you will be unable to move for a little while, unless you bleed them off.

Charging the Train.—While the train is charging the trainmen or inspector should pass along the train, examining it for leaks in the train-pipe and auxiliary pressures, repairing same to the best of their ability. When the train-pipe is charged to full pressure and is reasonably free from leaks usually the engineer gives a short blast of the engine whistle, signaling his readiness to test the brakes.

Testing the Brakes on Freight Trains.—Usually

the signal to apply brakes is given by the rear trainman or inspector, this is repeated by the head trainman or inspector; upon receiving the signal, the engineer should apply the brake with a full service application; the trainmen or inspectors should examine each car in succession as they move toward each other inspecting the brakes until each car is reached. Everything being all right, they give the signal to the engineer to release; they then retrace their steps, examining each car again, noting if all the brakes are released. The engineer should be advised how many, if any, of the brakes were cut out, the general condition of the brakes, and the tonnage of the train.

Handling Air Brakes on Freight Trains. Making the First Reduction.—When making the first reduction, remember it must be sufficient to push the piston in the brake-cylinder past the leakage groove in all the cars, or the brake will not only immediately leak off and the air be wasted, but the brakes on those particular cars cannot be set as hard as the others, as part of the air in the auxiliary-reservoir has escaped to the atmosphere through the leakage groove in the brake cylinder, thus reducing the pressure which cannot again be regained until the engineer's brake valve has been thrown in release or running position, releasing and recharging all the brakes. Again care must be taken not to make the reduction too heavy or serious damage will be done by the rapid bunching of the train. *Remember also* the

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the signal to apply brakes is given by the rear trainman or inspector, this is repeated by the head trainman or inspector; upon receiving the signal, the engineer should apply the brake with a full service application; the trainmen or inspectors should examine each car in succession as they move toward each other inspecting the brakes until each car is reached. Everything being all right, they give the signal to the engineer to release; they then retrace their steps, examining each car again, noting if all the brakes are released. The engineer should be advised how many, if any, of the brakes were cut out, the general condition of the brakes, and the tonnage of the train.

Handling Air Brakes on Freight Trains. Making the First Reduction.—When making the first reduction, remember it must be sufficient to push the piston in the brake-cylinder past the leakage groove in all the cars, or the brake will not only immediately leak off and the air be wasted, but the brakes on those particular cars cannot be set as hard as the others, as part of the air in the auxiliary-reservoir has escaped to the atmosphere through the leakage groove in the brake cylinder, thus reducing the pressure which cannot again be regained until the engineer's brake valve has been thrown in release or running position, releasing and recharging all the brakes. Again care must be taken not to make the reduction too heavy or serious damage will be done by the rapid bunching of the train. *Remember also* the

amount of reduction necessary to cover the leakage grooves, varies with the length of the train. Thus with a train of ten cars 4 to 5 pounds is generally sufficient. With a train of 25 or 30 cars a 6 to 7 pound reduction is required; with a train of 45 to 60 cars a 9 or 10 pound reduction; while a train of 80 or 100 cars generally requires about a 12 pound reduction. Many readers no doubt will want to know "the reason why" of this, since they may argue the volume of air contained in the equalizing or supplementary reservoir is always the same, regardless of the length of the train and consequently a reduction or expansion of the air in it is always made in the same manner. This is correct and true, but the volume of air in the train-line on the other hand increases with each additional car, while the size of train-line exhaust to the atmosphere always remains the same; so the longer the train the longer it takes to make a given reduction in the train-pipe. It is true with the Westinghouse brake valve the gauge will fall just as quickly also; but that is not connected with the train-pipe, but to the equalizing reservoir, so it does not represent the pressure in the train-pipe until they have had time to equalize. Now that we have learned why the air in the train-pipe reduces more slowly on a long train than a short one, we can also see that as the pressure reduces more slowly there is more chance for the air in the auxiliary to feed back into the train-pipe through the feed groove before it is closed by the triple piston moving past it.

Still again, the slower the train-pipe pressure is reduced (as would be the case on a long train) the more slowly the air will feed from the auxiliary-reservoir to the brake cylinder, and the more slowly this is done the more air will escape past the leakage groove to the atmosphere instead of forcing the brake piston out when the reduction is too light this prevents the brake that would set on a short train from doing so with the same reduction on a long one.

Following Reductions After the First.—Just as the first reduction must vary with the length of the train, so must the following reductions and the time between each vary. These succeeding reductions should range from 2 to 6 pounds. On a short train the reductions can be made fairly close together, but as the train grows longer more time must elapse between them. It must be remembered that if any reduction is followed by another before the train-pipe exhaust ceases, the two reductions will act as one. For example, if a reduction, say of 4 pounds, is made followed by one of 3 pounds while the train-pipe exhaust is still open, it will be the same as if a 7 pound reduction had been made in the first place. And as the longer the train the longer the train-pipe exhaust will blow, so the longer time you must wait before you should make another reduction.

Coming to Dead Stop on Freight Trains.—When the speed of long freight trains is reduced by brake applications to a comparatively slow speed (say less than 10 miles per hour) it is

policy to come to a dead stop before releasing. The head brakes release first, the slack of the train is liable to run out before the rear brakes release, and the result will be a break-in-two if the brakes are released before the train comes to a stop. Where the engine is equipped with the *combined automatic* and *straight air* brake, the *straight air* can be applied on the engine while releasing a *long* freight or passenger train at the slowest kind of speed without breaking-in-two.

Cut Off for Coal and Water on Freight Trains.—This is the best policy on long freight trains. It is not policy to expect an accurate stop with such a train. Always stop, cut off, get coal or water, then return and couple up, make the *road test* of air brakes and proceed.

Road Test of Air Brakes.—Whenever any train is uncoupled, to set out or pick up cars, cut a crossing or add an engine for a double header, the *road test* should be made after coupling on to the train. This test consists of a signal given to the engineer to apply the brakes, the head trainman should inspect the cars "picked up," while the rear trainman should note that the rear car will apply and release. The engineer should note the length of the *blow from the train-pipe* exhaust, as the length of the air brake train will be approximately as the length of the blow.

Using Steam After Releasing Brakes.—The brakes on a long freight train do not all release as soon as you throw brake valve handle into release position. The head brake releases first,

then the second and so on to the last car. Very many freight engineers forget this, and when they reach the bottom of a grade or after holding the brakes on coming up to a danger signal suddenly the signal drops, or being in a hurry to resume speed, the throttle is opened immediately after the brake handle has been thrown into release, and "break-in-two," or a jerk that is very trying to the draft rigging is the result. A good rule to follow is to allow one second for each car you have in your train that must be released; as it takes nearly a second for each car to release beginning with the one next the engine. For instance, if you have 20 cars, allow 20 seconds after throwing the brake handle into release position and so on. After you have done this a few times with trains of different lengths you soon become accustomed to the approximate length of time that has elapsed. Do not imagine you lose much time by doing this. In waiting these few seconds for the brakes to release, the train automatically takes up its own slack, which is accounted for by the rear brakes releasing last. And when you do use steam, you can use it without losing *any* time, in addition to being on the safe side.

Controlling Freight Trains on Grades.—See sections on *Special Apparatus. For Controlling Heavy Freight Train on Grades.*—Also to section on *Retaining Valve.*—In descending long heavy grades, begin to brake in time; do not wait until your train is going at a speed where a full application is necessary to check it, because it may not

"check" enough by the time your brakes need recharging. Set the brakes moderately in time and see that the trainmen close the required number of retaining valves. Always figure to recharge the brakes on a "let up" or where the grade is not so steep, or going around a curve; by so doing you will find your train will not gain so much headway while recharging. While recharging always use the brake valve in full *release,* and leave it there until both gauge hands start to pass 70. After recharging with retaining valves set, remember a few pounds reduction will be much more effectual than without the retainers. For example, if you make a 5 pound reduction without the retainer you are putting about 10 pounds pressure into an empty brake cylinder, where with the retainer set you would attain a braking force of almost 38, on account of the pressure retained in the brake cylinder by the retainer. Always make a 5 or 6 pounds reduction even if all retainers are set; as some of them may be out of order so as not to hold any pressure in the brake cylinder and in this event, unless you make a sufficiently heavy reduction to carry the brake heads past the leakage grooves, you would get no braking power from these brakes. Do not place too much reliance on the way your train is running for guidance in using the brake; watch the air gauge. Oft-times a small leak in the train-pipe, after making the first reduction, will leak just enough air away to make the nicest and smoothest kind of a run; but when it has leaked

down to 50 pounds or past it, you will have a hard time regaining control of your train and stopping would be out of the question until the brakes were again recharged, and probably by that time the train would be beyond control. Where the engine is equipped with the *Combined Automatic* and *Straight Air Brake,* the straight air feature can be used to help the retaining valves while recharging the automatic brakes. Engines equipped with straight air, also have the *Grade bleed* cocks, which should be opened on grade work, thus allowing the automatic feature of the driver and tender brakes to escape and not loosen tires.

What is Gained by Use of the Retaining Valve. —It will not be out of place here to give an idea of what is gained by use of the retainer. In the first place a braking force can be attained by a service application about equal to an emergency application without it; and by making an emergency application with retainers in use, we gain about 4½ pounds pressure more than an emergency application without retainers in use. To illustrate this a little more clearly, we will suppose that with 70 pounds of train-line pressure, the brakes are applied in *full* without using the retainers; the pressure in the auxiliary and brake cylinder will equalize at about 50 pounds. This is all the braking pressure that can possibly be attained with a service application. Now suppose the retainer handles are raised and the brakes released and auxiliaries recharged to 70 pounds.

The retainers have now held 15 pounds pressure in the brake-cylinder and we have got that to start with; so when we apply the brakes in full this time, the auxiliaries and brake-cylinders will equalize at about 55 pounds, which it will be noticed is but a few pounds less than the average pressure attained by an emergency application. Another advantage is, that it saves air. A 15 pounds reduction after retainers are in use applies the brakes in full; the other 5 pounds would have to be blown into the atmosphere and wasted to set the brakes in full if the retainers were not in use. Again air is saved on account of the large gain in braking power; the reductions need not be nearly so heavy or often. This will appear more clearly when it is understood that without the retainers, a 5 pounds reduction will give a brake-cylinder pressure of about 10 pounds and with the retainers holding a 5 pound reduction will give a brake-cylinder pressure of about 38 pounds. Why the proportion of gain with a 5 pounds reduction with the retainer is so great over that of a 5 pounds reduction without, is in a great measure due to the air escaping through the leakage groove, and past the leather packing before it becomes forced against the cylinder sides; the higher the pressure the tighter the packing will be. Also that no vacuum produced by the piston moving out, has to be raised to atmospheric pressure. When the brake is held applied by use of the retainers, this loss is avoided. Another, and by no means the least gain in using the re-

ainers is that the train can be run very steadily, moothly and safely, it can be recharged much nore quickly and is not so liable to be broken in wo as without them.

Miscellaneous Freight and Passenger: When Brakes Are Fully Applied in Service Application.—When a reduction has been made in the train-ipe till the auxiliary and brake-cylinder pressures are equal, no further reduction need be nade, as the brakes are fully applied. With the tandard pressure of 70 pounds the auxiliaries nd brake cylinders equalize when a continuous r almost continuous reduction of 20 pounds s made, or when the train-pipe gauge stands t 50 pounds. But when an application is nade in the ordinary way, covering the reater portion of a minute, or while descending a grade and the reductions are made far part, it requires a reduction of from 22 to 25 ounds to fully apply all the brakes depending pon the length of time between the first and last eduction. This is due to a portion of the air dmitted to the brake-cylinder leaking past the acking leathers. If a 20 pounds application is nade with a single reduction or within a very hort space of time, the air does not have time to eak past the packing leathers and therefore the uxiliaries and brake-cylinders will equalize with 20 pounds reduction.

An Over Reduction of the Pressure in the train-ipe after the auxiliaries and brake-cylinders ave equalized will be a waste of train-pipe air.

Yet it is a frequent practice with some engine
when they fear they will go past a station, to
tinue to make reductions until the train-
gauge reaches zero. An *over reduction* will
cause a *difficult release* of the brakes, as it wil
necessary to restore the amount over redu
along with the required pressure necessary
move the triples to release position. If an
reduction is not made, an increase of a poun
two *throughout* the entire length of the train-
will cause the brakes to release.

*How to Handle the Brake Valve in Relea
Brakes.*—When you desire to release the bra
always use the brake handle fully in "
lease" position regardless of the length of
train. When the brakes are all released, and
fore they are overcharged, return the b
handle to "*Running*" position. The length
time required in *Releasing* depends entirely
the length of the train and the amount of the
duction. Learn to release the brakes by o
sionally watching the air gauge. When the b
handle is placed on Release position, the n
reservoir and train-pipe air pressures should p
tically equalize but not overcharge; on s
trains this occurs rapidly, thus the brake ha
should be returned to *Running* position ra
quickly; on long trains, equalization is slow,
rear end of the train-pipe receiving its increas
pressure rather gradually. Give them plent
time to release. On long trains (over 30 cars)
head brakes (being nearest to the engine) ch

more rapidly than the rear ones on account of the train-pipe air containing a higher pressure at the head end than the rear, for some little time. This is due to the friction of the long train-pipe, during the effort of the air to reach the rear end. On long trains, when the handle is returned to *"Running"* Position, the train-pipe air equalizes from the head end to the rear end, thus causing the head brakes to reapply. This peculiar action on long trains, requires the brake valve handle to be again placed on "Release" position for a few seconds and again to "Running" position, thus getting rid of the light application of the head brakes. By this we note that long trains require a *double release* to be sure they are all off.

Never try to release the brakes by using the *"Running Position,"* for sooner or later you are going to make yourself trouble by having "stuck" brakes or flat wheels; in fact you are almost sure to get them, if the train consists of any considerable number of cars. It requires a rapid raise of train-pipe pressure to overcome the friction of the triple pistons and move them to release position so the air can escape from the brake-cylinder to the atmosphere. But if the air is admitted very slowly into the train-line, as is the case in trying to release in *running* position, the pressure in the train-line instead of pushing the triple pistons into release, will have plenty of time to leak by into the auxiliary-reservoir raising it eventually to 70 pounds without the triple piston moving, leaving the brake applied.

Why Brakes "Stick."—One of the most
blesome difficulties encountered by engi
while on the road is the question of brakes
ing, as it usually results in (1) the train p
while endeavoring to start, (2) stalling o
next hard pull or (3) flat wheels on the car
the result of pulling it from one stopping pl
another with the wheels sliding. Most of
troubles can be avoided by properly testir
brakes, paying particular attention to ho
brake valve is handled while releasing, as w
carrying the proper pressure. The followir
the usual causes of brakes sticking: (1)
ficient Excess Pressure. On long trains t
important. Always have sufficient excess f
brakes in the train before attempting to re
If the excess you have will not go far en
adjust it, or "lap" the brake valve and get
you need and try it again. (2) Not leavir
brake valve handle on release position
enough. The brakes usually stick near the
end of the train on account of the slow ra
train-pipe air. (3) Making light reduction
releasing. This is one of the most frequent c
of "brake sticking." Suppose you have a
train charged to 70 pounds pressure, whi
main reservoir has 30 pounds excess. I
pounds reduction is made the auxiliary and
pipe air will be left at 65 pounds pressure
an excess pressure of 35 pounds. If a 10 p
reduction has been made the auxiliary and
pipe air would be left at 60 pounds, with

cess pressure of 40 pounds. This explains why a heavier service application should be made and a more sure release follow, as the excess is greater and the auxiliary pressure is lower. Avoid light reductions on long trains, even though you should be required to make some reduction after stopping. (4) Overcharging. This is usually caused by leaving the brake valve handle on *Release* position too long when releasing brakes thus overcharging the train-pipe and auxiliaries. The leakage from the train-pipe is then not supplied by the pump as the excess valve, (D8 or New York brake valves) closes till the excess is again accumulated or with the F 6 or G6 brake valve, if the train-pipe pressure is raised above 70 pounds the *feed valve* closes. The leakage gets a chance to reduce the train-pipe air until the *overcharge* leaks off. In the meantime the brakes drag. Overcharging often occurs through imagination of brakes dragging. Very often as an excuse for stalling going up a grade, the engineer gives, "brakes stuck on train." He has doubtless told the truth, but he little realizes or suspects that he himself was the cause of the brake dragging; he will even go into details and explain how he endeavored, by repeatedly throwing the brake handle into full release to "kick" the brakes off but could not and after stalling, how he went back and found several stuck as he expected. This is how the engineer did his part in putting the brake on. He has already probably run half the trip and has not thought that a brake might be

sticking, because the train glided along and there was no reason to think so. But now a heavy grade is struck and the engine begins to labor heavily but is still going along nicely, then not as fast as he thinks she ought to. He becomes alarmed and his dread of the consequences of becoming stalled leads him to think that a brake "might" be stuck. So he throws his brake valve into release position and to make sure that the brake be "kicked" off, leaves it there possibly longer than he ordinarily would; then as the train still continues to seem to drag, he becomes thoroughly convinced that a brake must be sticking and over goes the brake handle into full release again; this time he leaves it there a little longer so as to be positively sure the brake will be released. Yet it is this very action that is overcharging. When the handle is brought into *running* position the leaks apply the brakes and the train stalls. Then a search is made for the "stuck" brake and found, and he heaves a deep sigh of relief; feeling positively sure that it was not his fault that he stalled, and that he had done all in his power to "kick" the brake off before stalling. While if he had done nothing—left his hands off the brake handle entirely, he would have gained the hill beyond doubt. (5) Leakage from the train-pipe applying brakes. Where the full air pressure has been maintained and leakage actually takes place from the train-pipe, the reduction thus caused will naturally apply the brakes. The leakage referred to, usually occurs when trains are stretched after

standing, particularly in winter, when the air hose are frozen; the hose being stiff, pull partially apart instead of being as flexible as they should be. Another cause for leaks applying the brakes, is a *defective governor* or *train-pipe feed valve.* Where either of these interfere with the supply of air to the train (the governor holding the pump idle or the feed valve closing the supply to the train) the leakage gets a chance to apply the brakes. Sensitive governors and feed valves are essential to enable the air pump to keep a constant supply of air passing to the leaks of the train. Therefore keep them clean and if found defective have them repaired. This latter kind of "brakes dragging" will be accomplished by a gradual fall of the train-pipe hand of the air gauge. If the gauge hand does *not show a reduction* the leakage of the train-pipe *is not applying the brake.*

How to Release Brakes That Are Dragging.— If from some of the above five causes the brakes are actually dragging they can be successfully released and "kept off" by either of the following methods according to the cause. (1) If the train-pipe air is below the standard pressure (which it will be if leakage applies the brakes or more air brakes are cut in) and you have the proper excess pressure, place the brake handle in *Release* position as in *Releasing brakes* ordinarily. (2) If train-pipe air is up to full pressure and the brakes are actually applied (which they might be if improperly handled) just make a 10 pounds reduc-

tion and *Release* properly. Do this before starting and then keep the brakes off by supplying the train-pipe leakage. (3) If the train-pipe air is below standard and you have no excess, just "lap" the brake valve, accumulate the necessary amount and then *Release* properly. Never try to pump the brakes off.

Emergency Stops.—The Emergency Application of the Brakes must not be used, except in actual emergencies. There is no better method of accomplishing this than the right way—viz., Place the handle into full emergency application as quickly as possible and leave it there, starting a flow of sand at once. The energies of your mind and body should be absorbed in getting stopped. Of course it is not meant by this assertion, that it is not possible to get the emergency action of the brakes without losing all the train-pipe air; but it is not good policy to try to save it in times of pressing danger, and should never be advocated under any circumstances, lest the engineer when called upon to act under exciting circumstances should get confused. In the first place if it is practiced when several cars with plain triples or with brakes cut out happen to be placed together, only the brakes ahead of such cars will go into emergency action, while those after them will set with perhaps only a partial service application. While if the valve had been left in emergency application, a full service application would have been had in all cars back of, in addition to the full emergency on those ahead of, the cars with

plain triple or "cut outs." But the greatest possibility and danger is that during the excitement, the engineer, while bringing the valve back to lap, will move it a little too far, getting it into running position, thus releasing the brakes. If the valve was moved to lap too quickly the surge of the air in the train-pipe would "kick" off the forward brakes. If the brakes have been partially applied by a service application, you will not get a full quick action emergency application; if the reduction has not been too great you will obtain a partial one. In any event or condition except the brakes have been fully applied, you get the most by placing the handle into full emergency and leaving it there.

Reversing the Engine When Brakes Are Applied.—When the driver brakes are applied, the engine should never be reversed with the expectation that a shorter stop can be made, than with the brakes alone; for under these conditions, the drivers are almost sure to lock and then nearly the whole retarding power of the engine has been lost. It has been proved beyond all manner of doubt by the most careful and exacting tests, that a train can be stopped quicker and consequently in a shorter distance with the brakes applied alone, than with the brakes applied and engine reversed. In close quarters the tendency is to reverse, in addition to applying the brakes. If this act has not been directly the cause of many wrecks, it has certainly not been the cause of preventing any. Placing your brake handle in

the "emergency" leaving it there, and starting t flow of sand, is doing all that is possible to sto the train.

When Brakes Apply Suddenly Without th Action of the Engineer.—Whenever the brakes g on suddenly without using them from the engin always shut the engine off and place the handle o "lap" at once, as a hose has burst, the train c hose has parted or a conductor's valve has bee opened. In doing so you avoid as much damag as possible and maintain the main reservoir ai having it to release the brakes when the tim arrives for so doing.

When a Hose Bursts.—As already instructe in the event of any sudden reduction, witho action on your part, and you feel the brakes g on to emergency, immediately lap the brak handle. Very often a burst hose is difficult t locate, as there is no pressure in the train-lin and the bursted portion usually closes up, so tha it is hard to be seen; therefore as the trainme proceed along the train and as they pass each ca throw the brake-valve from the lap to Runnin position for a moment, repeating the operatio until the defective hose or "bad leak" is found By this means, it can very readily be located b the trainmen by the intermittent sound of the es caping air. If you find you have no extra air hose on the engine (though you always shoul have one), don't forget that you can take the las hose off the last car, or the one on the head en of the engine, to replace the bursted one.

Breaking-in-Two.—The best course to pursue on this situation must depend somewhat upon where the break-in-two occurs, whether it is on all-air train or not. In case it is an all-air train no matter where the break occurs, the best course to pursue is always the same: Lap the valve at once and shut off the engine throttle. Both sections of the train will stop. Never try to keep the forward section out of the way of the rear, because the brakes next the engine cannot be released, and if the train is going to come together, the closer they are the less damage will be done. As soon as the sections come to a standstill, the last angle-cock of the front section must be closed, so the brakes can be released and backed up and coupled to the rear section. A test of the brakes should then be made before proceeding to see if they are working properly. In case it is a part-air train, the course to pursue will depend upon whether the break occurs between the air-cars, or in the rear of them. If it occurs between the air-cars, you are bound to pursue the same course as with an all-air train. In this case it is almost impossible to prevent the rear portion running into the head-end, but if the engine throttle is shut off promptly, the two sections will seldom be separated far enough to do any damage. In the event of the break being in the rear of the air-cars, they of course will not affect the brakes on the head-end, and as there will be no brakes on the rear end to stop it except those that will be applied by the trainmen, the forward section must be kept in

motion and out of the way of the rear end until it is brought to a stop. The regulation whistle signal for break-in-two should of course be given in all cases, as well as the usual precautions for the safety of the train to prevent its being run into by other trains.

Releasing Brakes After an Emergency.—The most frequent cause of brakes not releasing promptly after an emergency, is due to the manner in which the engineer recharges the train-line. When an emergency has been made the brake cylinder and auxiliary have equalized at a high pressure, particularly Westinghouse, on account of the extra air from the train-line. Now as the air has been all let out of the train-line, the only available air to release the brakes is in the main reservoir, which, when allowed to pass into the train-pipe of a comparatively long train, will not be near the auxiliary pressures; yet it must be more than this to release the brakes. The pump then completes filling the train. The brakes with tight triple piston packing rings release, but the ones that are defective leak air into the auxiliary-reservoir which increases the pressure there as fast as the train-pipe pressure raises, consequently these brakes will remain "stuck." The proper way to release these brakes after an emergency, and the way in which you will have the least number of "stuck" brakes, is to throw the brake handle into full release and leave it there until the pump has accumulated a pressure in the train-line and main reservoir of about 50 pounds;

e the brake handle on lap until you have full
ı reservoir pressure; then make another
ıer release.

cking Up Cars.—When the engine is backed
o cars lying on a siding that are to be picked
ınd added to the train, or when an engine is
ıled to cars that are intended to be moved
kly, it is a good plan to apply and release the
ne brakes several times while backing up to
cars, and then let the brake valve remain on
ıntil the air hose of the cars is coupled to the
ne. This reduces the pressure in the engine
tender auxiliaries and whatever cars are
ıled to the engine, so that when more air
e cars are cut in, it will take but a very short
for them to be released, and you will be able
ıove at once. Otherwise the amount of air
ired to charge the cars added, would be so
t that the brakes on engine and tender would
ıin set and you would not be able to move
the train-pipe air could be raised above their
lized pressure.

ıuble Headers.—When two or more engines
coupled together and the brakes are coupled
ugh to the head engine, as they should always
n going a distance, they must always be
lled by the engineer on the head engine.
'e is a cock placed in the train-pipe just below
engineer's brake valve, which must be closed
ach engineer on every engine except the head
the brake handle should be left in the *run-*
position and the pump run in the usual way,

so that, should the head engine fail or be cut loose from the train, you will immediately be prepared to take charge of the train; also to help charge the train should it become necessary to do so. But never under any circumstances must you "cut in" while in connection with the engine ahead, unless signaled to do so by the engineer in charge of the leading engine. Do not forget to open the cock as soon as the engine ahead of you is "cut off," so as to be able to operate the brake immediately.

Instructions for Operating the Combined Automatic and Straight Air Brake.—(1) Always keep both brakes cut in ready for use, unless failure of some part requires cutting out. (2) An excess pressure should always be kept in the main reservoir to insure satisfactory operation. (3) Keep the Straight Air Brake Valve in "Release" position when using the Automatic, and keep the Automatic Brake Valve in "Running" position while using the Straight Air. This rule should be observed to avoid sticking of the driver and tender brakes when releasing. (4) Ordinarily the Automatic Brake should not be used while the Straight Air is applied. If the Automatic is wanted, after the Straight Air Brake has been applied, release the Straight Air before applying the Automatic. This rule does not apply in case of Emergencies. (5) The use of the Straight Air Brake while the Automatic Brake is applied will not increase the driver and the tender brake cylinder pressures above 45 pounds but the release of

her brake is not certain while the other brake lve is on "lap" or in "application" position.) It should be remembered that the Straight Air ake on the driver and tender is nearly as power- l as the Automatic Brakes on the same, and at it should be used with care to avoid rough ndling of trains and, in holding down long ades, to avoid loosening of tires on drivers.) The Straight Air Reducing Valve should be pt adjusted at 45 pounds, and the Driver and nder Safety Valves at 53 pounds. When the fety Valves operate under a full application of e Straight Air-Brake, it indicates that either the ecial Reducing-Valve or the Safety-Valve is t of adjustment, and they should be tested and justed at once. (8) When brake-cylinder fety-valves or grade-cocks are located in the b and near the tender-deck, the hand-release, th which they are provided, may be used to reg- ate the cylinder pressure or to release the akes on the engine and the tender, when neces- ry to prevent wheels sliding or over-heating of es.

When Leaving the Engine After Trip.—When aving the engine at the terminal, the engineer ould use his best efforts toward inspecting the rts of the engine which are subject to defects. ne application of the air-brake equipment to comotives has brought with it a vital point that eds consideration, *i. e.*, its maintenance. No her person should be more interested than the gineer, from the fact that his ability to perform

his work satisfactorily, and his safety, depend i great measure upon the modern safety-applianc the air-brake. The engineer should make a tho ough investigation of the performance of the ai brake equipment and report the defects to be r paired, paying particular attention to the diffe ent parts to which ailments are liable to occu The inspection practically includes the irregula ities of the air-pump, the pressure-regulators, t brake-valve and triples in their combined actio of operating the brake-pistons. Particular atte tion should be given to brake-cylinder leakage an piston travel, as this is practically where the wo is done when stopping. To stand inspection an be considered in good serviceable condition, t air-brakes should apply with a service applicatio and remain so for several minutes without relea ing or leaking off. The piston travel should b within reasonable limits—cam-driver brakes 2 to 4 inches travel on each side; American Drive brakes 4 to 5 inches on each side; engine-truc and tender-brakes, 6 to 8 inches. This caus each brake to equalize at the proper pressure. the engineer finds any irregularities, he shou make a report of same to the repairman on t report slip for that purpose.

Reporting Defects.—The best manner of r porting air-brake work is to explain the sym toms—*how the brake acts.* Learn the princi of the brake, and study its defects, so that y may be the master of the machine you have cho to operate.

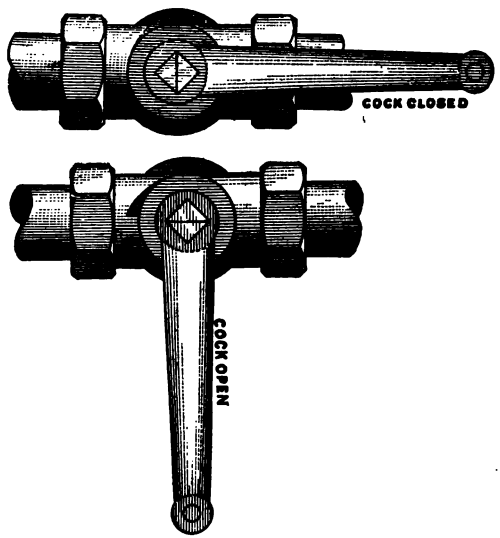
CHAPTER XXVI.

GENERAL INSTRUCTIONS TO TRAINMEN, SWITCHMEN, YARDMEN AND CAR INSPECTORS.

Making Up Trains and Testing Brakes—When an engine has been coupled to a train, or when two sections have been brought together, the brake-couplings should be united. The cocks in the train-pipes should then all be open, except at the rear end of the last car. This should be closed and the hose properly hung up in the dummy coupling. After the engineer has fully charged the train with air, he will then be signaled to apply the brakes. When the train air-signal is to be used, the signal to the engineer to apply the brakes should be given by means of the air-signal from the rear car of the train. When he has done this, the brakes of each car will be examined to see if they are properly applied. When this is ascertained to be so, the engineer will be signaled to release the brakes. The brakes of each car should then be examined to see that each is released. The longer the brakes can be left applied, it should be remembered, the more thorough will be the test of their stopping power.

If any defect is discovered, it should be remedied and the brakes applied again, the operation

being repeated until everything is righted. In the event any cars are cut out or defects found, the conductor and the engineer should be notified as to the condition of the brakes, the number of cars working and those that are cut out because of defects. An examination should be made



The Plain Straightway Cock.

FIG. 97

every time any change is made in the makeup of a train, also before starting down such grades as may be particularly designated. At points where there are no inspectors, trainmen will carry out these instructions.

A passenger train should never start from an inspection point with the brakes upon any car cut

it or in a defective condition without orders om the proper official.

Use of Hand-Brakes.—The air-brakes on a eight train should not be wholly relied upon to ntrol the train, if there is a smaller proportion f cars with the air-brake in service than the reg-lations of the company specify. When hand-rakes are also used, they should be applied upon ie cars next behind the cars with air-brakes, ex-ept when backing up, in which case the braking ould, in the main, be done by hand-brakes at ie rear of the train.

Detaching Engine or Cars.—When the engine r a car is detached, the cocks in the train-pipes t the point of separation should first be closed, ie one nearer the engine last. The couplings ould then be parted by hand. If the brakes ave been applied, the cocks should not be closed ntil the engineer has released the brakes upon ie whole train.

Frozen Couplings.—If the couplings should at ny time be found to be frozen together or cov-ed with ice, the ice should first be removed and ie couplings thawed out by a torch or by dipping nto a pail of hot water, so as to prevent injury o the gaskets.

Brakes Sticking.—If the brakes should be ound sticking, the engineer should be signaled to elease them. If he cannot do so and calls for elease, or if the brakes are applied to detached ars, the release may be effected by opening the nall cock in the auxiliary reservoir until the air

begins to release through the triple-valve, when the reservoir-cock should immediately be closed.

Train Breaking Into Two or More Parts.—The cock in the train-pipe at the rear of the first section should first be closed and the engineer signaled to release the brakes. After having coupled to the second section, the rule for making up trains should be observed, first being sure that the cock in the train-pipe at the rear of the second section has been closed, in case the train has broken into more than two sections. When the engineer has released the brakes on the second section, the same method should be employed with reference to the third section, and so on. When the train has been reunited, the brakes should be inspected on each car, to see that all are released before proceeding.

Cutting Out the Brake on a Car.—If, through any defect of the brake apparatus, while on the road, it becomes necessary to cut out the brake upon any car, it may be done by closing the cock in the cross-over-pipe near the center of the car, when the quick-action brake is used, or by turning the handle of the cock in the triple-valve to a position midway between horizontal and vertical when the plain automatic-brake is used. When the brake on a car has been thus cut out, the cock in the auxiliary reservoir should be opened and left open upon passenger cars, or held open until all the air has escaped from the reservoir upon freight cars. The brake upon any car should never be cut out unless the apparatus is defective, and when it is necessary to do so, the conductor

uld notify the engineer and also send a report the proper official, stating the reason for so ing. Some form of noticeable defect tag tied the defective part is very effective. This tag uld give the car number, initials, state the de-t, and be signed by the conductor, giving the te.

Conductor's Valve.—Should it become neces-ry to apply the brakes from the train, it may done by opening the conductor's valve, which placed in each passenger equipment car. The lve should be held open until the train comes a full stop, and then closed. This method of pping the train should not be used except in se of emergency.

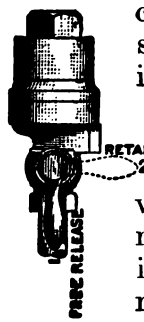
Burst Hose.—In the event a brake-hose should rst, it should be replaced and the brakes tested fore proceeding, provided the train is in a safe ace. If it is not, the train-pipe-cock immedi-ely in front of the burst hose should be closed d the engineer signaled to release the brakes. l the brakes to the rear of the burst hose uld then be released by hand and the train ved to a safe place, where the burst hose uld be replaced, the brakes connected and sted as in making up a train.

Call for Brakes.—When the engineer calls for akes, the conductor's valve or rear angle-cock convenient) should be opened first. Each inman should then set the brakes nearest to n, whether the air-brake is applied on the car not.

Brakes Not in Use.—When the air-brakes are

not in use, either upon the road or in switching, the hose should be kept coupled between the cars or hung up properly in the dummy couplings.

Pressure Retaining-Valve (Figure 98).—In descending long grades, owing to repeated applications of the brakes, the stored pressure may become so reduced as to make it necessary to recharge the auxiliary reservoirs. This the engineer cannot do without releasing the brakes, but the retaining valve is designed so that the trainmen may hold a pressure of fifteen pounds in each brake-cylinder while the engineer is re-charging the reservoirs. This valve is conveniently located up near the hand-brake in a position accessible on a moving train. A pipe from the bottom of the retaining-valve connects it with the triple-valve exhaust. When it is desired to retain fifteen pounds pressure in the cylinder, the handle of the retaining-valve is changed from position one to position two before the brake is released by the engineer. At the foot of the grade the handles should all be turned downward again to position one. Special instructions are issued as to the grades upon which these valves are to be used.



The Pressure Retaining Valve

FIG. 98

Reporting Defects to Inspectors.—Any defect in the air-brake apparatus discovered upon the road should be tagged and reported to the inspector at the end of the run; or, if the defect be a serious one in passenger service, it should be

eported to the nearest inspector and remedied efore the car is again placed in service.

Extra Hose.—Each conductor should keep two xtra air-brake hose on hand. Passenger crews ould also have extra air-signal hose. To insure is, inspectors are authorized to exchange new ose for old, defective hose, whenever presented.

Blow-Out Hose.—Dust, dirt and cinders are e greatest enemy of the air-brake. Since the r-brake is the trainmen's best friend, trainmen ould do everything possible to keep dirt out of e air-brake apparatus by blowing out or shak- g dirt from all couplings before uniting them. etting quick action should be avoided by open- g cocks slowly, as quick action throws sand d dirt into the triple-valves and cylinders and uses many leaks.

Coupling and Uncoupling.—After coupling the ose, the hose-cock nearer to the engine should rst be opened and the hose tested; then the other ck should be opened slowly to prevent setting e brakes in emergency.

In uncoupling, the farther hose-cock from the gine should be closed first.

The hose should always be cut by hand before ncoupling the draw-bars.*

Discovering Leaks.—This should always be ne before any test of the brakes is made and hile the train is being charged. When there is strong wind and leaks cannot be heard, yet the

*Before coupling an engine to a train or in picking up charged airbraked cars, it should be ascertained that the cks on all the cars are right, otherwise all the air may be rown away through some open angle cock.

pump indicates excessive leakage, all commun tion between the engine and train should be clo and the engine thus tested. The engine be found tight, the rear half of the train should t be cut off, thus testing the first half with the gine connected. Whichever half of the train i is proven to have the leakage should be ag divided—the one part connected to the eng and the other detached, continuing this divis of the defective part until the leakage is loca and repaired.

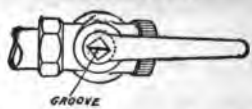
If leaks occur between hose-couplings on count of worn gaskets, a wooden wedge, such a match (preferred) a nail, placed betw the lugs of the coupl will generally prove fective (Figure 9 Paper gaskets sho not be used, nor the coupling lugs bent down pounding. Leaky hose or pipes can often be t porarily fixed by covering the part with a pi of old hose split open and then wound tigh with wire or string.

STANDARD HOSE COUPLING.
FIG. 99

Emergency When Service is Intended.—Wh ever brakes, being properly tested, set qu action, it is due to some triple-valve in the tr being defective. The car having the defec valve can be located by dividing the train parts as described for locating leaks, each t having the engineer charge and apply the bra fully in service application the same as test

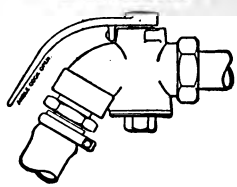
ı the car is found it should be cut out and its
leased and the whole train again tested.
arging.—Trainmen should bear in mind that
minutes is practically the shortest time in
ı an auxiliary reservoir can be charged;
the brake will not set until this is done; and
if they attempt to test the brake sooner than
they are simply wasting time, as the car is
harging as fast with the train-line pressure
reduced.
charging long freight trains with small leak-
an eight-inch air-pump should require about
alf as many minutes as there are cars; a
and one-half inch pump should charge in
half the time.
-Cocks.—There are two varieties of air-
in use, as illustrated—the straight-way
(Figures 97 and 101)
he angle cock (Figure
As a handle changed
one style of cock to
other, and bent or
ghtened to correspond
ppearance, would pro-
an effect just the oppo-
of what its position
l indicate, notice should
ken of the groove in the
f all air-cock plugs. This
ve always stands length-
with the pipe to be
and across the pipe to

THE ANGLE COCK.



Angle Cock Open—Top View.

THE ANGLE COCK.

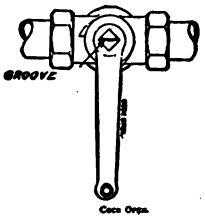


Angle Cock Open.

FIG. 100

be closed, immaterially of how the handle points. (See Figures 100 and 101.)

On account of its construction, when an air-cock sticks, the top of the plug should be tapped down; if too loose, pull up on it by means of the handle.



THE PLAIN STRAIGHT-WAY COCK.

FIG. 101

Cars Cut Out.—When two or more engines are coupled to a train, it should be seen that the first car is equipped with a quick action brake in working order. (Figure 103 shows the appearance of a freight-brake with a quick-action triple-valve attached.)

No more than three piped cars,* or cars equipped with the plain triple-valve, should be placed together in a train, as quick action may not skip these cars and apply the brakes behind them properly in emergency.

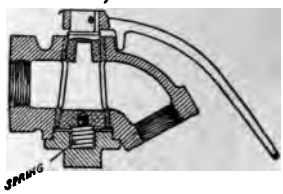


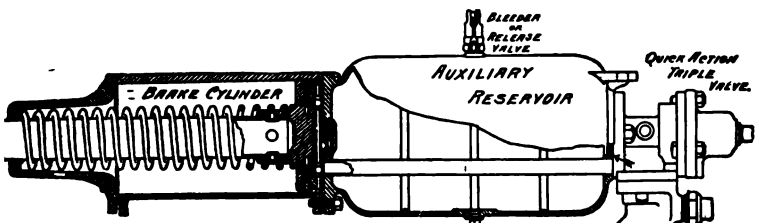
FIG. 102

Disabled Cars.—Whenever it is necessary on a freight or passenger train to place a disabled air-car behind the air-braked cars in use, the hose should be coupled to the next car ahead, the angle-cock opened on the car ahead, but the angle-cock on the disabled car closed. This keeps pressure in the hose coupling, and if the train should

*A Car with the brake cut out is the same as simply a piped car.

part there, the brakes on the head section would apply before the parts were far separated.

On passenger trains, when a change in the order of the cars would materially affect the convenience of the train, if the train-line on any car should become disabled, the signal-pipe of the car could be used as the train-line by utilizing a short combination coupling at each end of the car. Such a coupling is formed by a short piece of hose with a signal-coupling on one end and a train-line coupling on the other.



STANDARD FREIGHT CYLINDER, RESERVOIR AND TRIPLE VALVE.
8 IN. DIAMETER BY 12 IN. STROKE.

FIG. 103

Hand-Brakes on Air-Braked Cars.—In setting out air-braked cars, where safety requires that the hand-brakes be set, all the air should first be bled from the cars. A failure to observe this precaution may be disastrous in its results; for the air of the car may release the hand-brake, and then leak off, or it may cause the hand-brake chain to break—either of which leaves the car without a brake to hold it.

Releasing Brakes.—When it is necessary to re-

lease a brake by the release valve, or "bleeder," it should be held open only until the air commences to escape from the triple-valve. If held open longer, it has a tendency to set brakes on other cars with which the car is connected.

Triple-Valve Blowing.—A constant blow from the exhaust port of a quick-action triple-valve can generally be stopped by tapping on the heavy flanges of the triple-valve, or by setting this car in emergency. To do this latter, the car should be detached from others, else the stopping of this one blow may cause several other triple-valves to act similarly—as emergency is what usually gets the dirt into the triple-valve in the first place.

A continuous blow from the retaining-pressure-valve is a triple-valve blow and should be treated accordingly; the retaining valve should never be turned up or its exhaust plugged to stop such a blow, as then there is no way for the brake to release after it is once set.

A Retainer Stopped Up.—This can be overcome by removing from the triple-valve the small plug that is opposite the point where the retainer-pipe enters the triple. The plug should be left out until the retainer is repaired.

Leaving Train at Terminals.—The engine should not be uncoupled from the train until all the air-brakes have been released. If a few seconds be allowed after releasing, they are less liable to re-apply after the engine is detached.

Test Brakes After Any Change.—Although the

nal and train-line couplings are not inter-
eable, when the gaskets are worn they can
mes be forced together. Hence, a test of
r train-signal and the brakes on a pas-
train, if any coupling has been made or
d, should always be made. In passenger
of to-day, with its high speeds, the safety
sengers and property depends upon the air-
and a test of the brakes once too often is
than to omit it. Forgetting to open an
ock has caused more so-called "air-brake
s" than anything else. Every one is liable
akes of this kind on freight as well as pas-
trains, but a failure to test thereafter
criminal carelessness.

ating the Train Air Signal.—In using the
ir-signal care should be taken to give sud-
ll openings of at least one full second to
discharge valve and then allow an inter-
at least two seconds between pulls. Signal
tus in quite a defective condition can
be operated successfully by making even
r blast and interval.

ak in the air signal-pipe on a train will
more perfect signals to be given forward
leak than to the rear of it, thus often locat-
o the car.

litional Instructions to Switchmen and Yardmen.

e of Leaks.—Pulling hose apart, instead
oupling them by hand, and knocking cars

together hard in coupling draw-bars, are the causes of many broken and leaky pipes on air-braked cars. If badly leaking, it may necessitate the switching of them out of the air-braked portion of a train, the trouble thus reverting to those who caused it.

"Bleeding" a Train.—If yardmen have to "bleed" a train in order to switch it, there are three ways of doing it, and the amount of time required is in the order in which they follow: (1) Couple the train to an air-equipped switch engine and have the brake set and released repeatedly in service application until the pressure is exhausted from the auxiliary reservoirs. (2) Slowly open an angle-cock at one end of the train and leave it open; then "bleed" each car by the "bleeder." If the angle-cock be opened quickly, instead of slowly, and the brakes thus applied in emergency, it will take twenty per cent. longer to "bleed" the train, as there will be about ten pounds more air to release from each auxiliary. (3) If the train is not to be switched for half an hour or so, make a slight leak at one end of the train-line—so slight that the air will escape through the leakage grooves in each cylinder without setting the brake. These leakage grooves are about three inches long, and hence if the air does not enter the brake-cylinder fast enough to push the piston past these grooves, the brakes will not apply.

General Instructions for Car Inspectors.

It is the duty of all inspectors to see that the ouplings, pipe-joints, conductor's valves, and ll other parts of the brake apparatus are in ood order and free from leaks. For this purose they should be tested under a full air pressure of seventy pounds and all defects remedied. o passenger train should be allowed to leave a rminal station with the brake upon any car cut t or in a defective condition, without special ders from the proper official.

If a defect is discovered in the brake apparatus a freight car which cannot be held long enough repair such defect, the brake should be cut out d the car properly carded, so as to call the tention of the next inspector to the repairs reired.

Making Up Trains and Testing Brakes.—In aking up a train, the couplings should be united d the cocks at the ends of the cars opened, expt at the rear of the last car, where the cocks ould be closed and the couplings properly hung in the dummy couplings. After the train is arged, the engineer should be signaled to apply e brakes, using the train air-signal from the ar car for passenger trains. The brakes upon ch car should then be examined to see that they e properly applied. This having been ascerined, the inspector should signal the engineer release the brakes. The brakes should again examined to note that each is released. If

any defect is discovered, it should be corrected, and the testing of the brakes repeated until they are found to work properly upon each car. The inspector should then inform both the engineer and conductor as to the actual condition of the brakes.

Cleaning Cylinder and Triple-Valves.—The brake-cylinders and triple-valves should be kept clean and free from gum. For this purpose they should be examined as often as once in six months upon passenger cars and once in twelve months upon freight cars. The cylinders and triple-valves should be thoroughly cleaned after removing all movable parts, and the piston-leathers and cylinders well coated with a heavy oil or light grease which is but little affected by changes of temperature and will not gum. The dates of the last cleaning and oiling should be marked with paint upon the cylinder in the places provided opposite the words stenciled with white paint in one-inch letters upon the cylinder, as follows:

Cyl. oiled .....Date.....
Cyl.
Triple Cleaned .....Date.....
Place .....

It is well to give the pistons a one-half turn when replacing them in their cylinders.

The triple-valves and auxiliary-reservoirs should be frequently drained, especially in cold

eather, by removing the plug in the bottom of ıe triple-valve and opening the small cock in the ɜservoir.

Adjustment of Brakes.—The slack of the rake-shoes should be taken up by means of the ead truck levers or the turn-buckles. In taking p such slack, it should be first ascertained that ıe hand-brakes are off and the slack all taken ıt of the upper connections, so the live truck vers do not go back within one and one-half ıches of the truck timber or other stop, when ıe piston of the brake-cylinder is fully back at ıe release position. If, when under full applica-on, the brake piston travel is found to exceed ght inches upon a passenger car or nine inches ɔon a freight car, the slack of the brake-shoe ıould be taken up and the adjustment so made ıat the piston shall travel not less than five ches nor more than six inches.

Braking Power.—When the cylinder lever has ore than one hole at the outer end, the different ɔles are for use upon cars of different weights. should therefore be carefully ascertained that ıe rods are connected to the proper holes, so ıe correct braking power shall be exerted upon ıch car.

Repair Parts.—Inspectors should keep con-antly on hand, for repairs, a supply of all parts the brake equipment that are liable to get out order.

Hanging Up Hose.—Inspectors should see that, ıen cars are being switched or are standing in

Adjustment of Brakes.—The driver-brakes should be adjusted so that the pistons will travel not less than one-fourth nor more than one-half of their stroke. When the cam-brake is used, care should be taken to adjust both cams alike in order that the point of contact of the cam should be in line with the piston-rod. The tender-brake must be adjusted by means of the dead-truck levers, so the piston will travel not less than five nor more than six inches when the air-brake is applied and the hand-brake released. This adjustment should be made whenever the piston travel is found to exceed eight inches. The engine-truck brake should have a piston travel of not less than one-half nor more than three-fourths of the length of the cylinder, and must be adjusted alike on both sides.

Brake-Cylinders and Triple-Valves.—The brake-cylinders and triple-valves should be examined and cleaned once every six months, and the cylinders oiled once in three months. If the driver-brake cylinders are in a position to be affected by the heat of the boiler, they must be oiled more frequently and the pistons given one-half turn. Record should be kept of the date of each cleaning and oiling.

Draining.—The main reservoir and also the drain-cup in the train-pipe under the tender should, after each trip, be drained of any accumulation. The auxiliary reservoirs and triple-valve should also be drained frequently, daily in cold weather, and the train-pipe under the tender blown out.

APPENDIX

EING DRAWINGS SHOWING THE DETAILS OF THE "WESTINGHOUSE" AND "NEW YORK" AIR BRAKES.

—ALSO—

SCRIPTIONS AND INSTRUCTIONS FOR MANIPULATION F THE WESTINGHOUSE "ET" ENGINE AND TENDER BRAKE EQUIPMENT, MODERN WESTINGHOUSE AIR PUMPS, MODERN WESTINGHOUSE TRIPLE VALVES AND THE NEW YORK LOCOMOTIVE BRAKE EQUIPMENT, STYLE B3.

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The following are the details of the

WESTINGHOUSE AIR BRAKE

Illustrated in the following pages:*

Diagramatic Illustration of the Westinghouse Quick-Action Automatic Brake, Plate G1.
Westinghouse-American Locomotive and Tender Equipment, Plate G2.
Westinghouse Standard Passenger Car Brake and Signal Equipment, Plate G3.
Six-Inch Pump, Plate B6.
Eight-Inch Air-Pump, Plate F5.
Nine and One-Half Inch Air Pump, Plate F4.
Eleven-Inch Air Pump, Plate G5.
Engineer's Brake Valve, Plate G6.
One-Inch Pump Governor, Plate F7.
Detail Parts of Engine and Tender Brake Apparatus, Plate G9.
Pressure Heads for Brake Cylinders, Plate G14.
Standard Push-Down Type Driver-Brake Cylinders, Plate F15.
Standard Push-Up Type Driver-Brake Cylinders, Plate F17.
Standard Type "B" Push Driver-Brake Cylinders, Plate F19.
Standard Type "C" Push Driver-Brake Cylinders, Plate F20.
Standard Type "D" Engine Truck Brake Cylinders, Plate F21.
Piston Cross Heads for Driver-Brake Cylinders, Plate F22.
Reservoirs, Plate G23.
Plain Triple Valve for 8-inch and 10-inch Cylinders, Plate G24.
Plain Triple Valve for 12-inch, 14-inch and 16-inch Driver-Brake Cylinders, Plate F25.
Tender-Brake Cylinders, Plate G26.
Quick-Action Passenger Triple Valve, Plate F27.
Ten-Inch Passenger-Car Brake Cylinders, Plate F28.
Quick-Action Passenger Triple Valve, Plate F29.
Twelve-Inch Passenger-Car Brake Cylinder, Plate F30.
Fourteen-Inch Passenger-Car Brake Cylinder, Plate F31.
Sixteen-Inch Passenger-Car Brake Cylinder, Plate H52.
Detail Parts of Passenger-Car Brake Apparatus, Plate G32.
Westinghouse Standard Train Air-Signal Equipment, Plate F33.
Detail Parts of Train Air-Signal Apparatus, Plate G34.
Westinghouse Standard Freight-Car Brake Equipment, Plate G35.
Quick-Action Freight Triple Valve, Plate F36.
Narrow-Gauge Freight-Car Brake Cylinder and Auxiliary Reservoir Combined with "F36" Triple Valve, Plate F37.
Narrow-Gauge Freight-Car Brake Cylinder and Auxiliary Reservoir Detached, with "F36" Triple Valve, Plate F38.
"Twin Cylinder" Freight-Car Brake Apparatus with Auxiliary Reservoir Detached, and "F36" Triple Valve, Plate F39.
Standard Freight-Car Brake Cylinder and Auxiliary Reservoir Combined, with "F36" Triple Valve, Plate F40.
Standard Freight Car Brake Cylinder and Auxiliary Reservoir Detached, with "F36" Triple Valve, Plate F41.
Short-Stroke Freight-Car Brake Cylinder and Auxiliary Reservoir Combined, with "F36" Triple Valve, Plate F42.
Standard Ten-Inch Freight-Car Brake Cylinder and Auxiliary Reservoir Combined, with "H49" Triple Valve, Plate H50.
Detail Parts of Standard Freight-Car Brake Apparatus, Plate G43.
High-Speed Brake Automatic Reducing Valve, 1898 pattern, Plate F45.
High-Speed Plain Triple Valve, Plate F46.
Duplex Pump Governor, Plate F47.
Detail Parts of High-Speed Brake and High Pressure Control Apparatus, Plate F48.
Diagramatic Illustration of the Westinghouse High Pressure Control Apparatus, Plate G49.
Diagramatic Illustration of the Westinghouse Standard High Speed Brake, Plate G50.

*Similar detailed drawings of the New York Air Brake are given further on in this appendix

PLATE G 1.

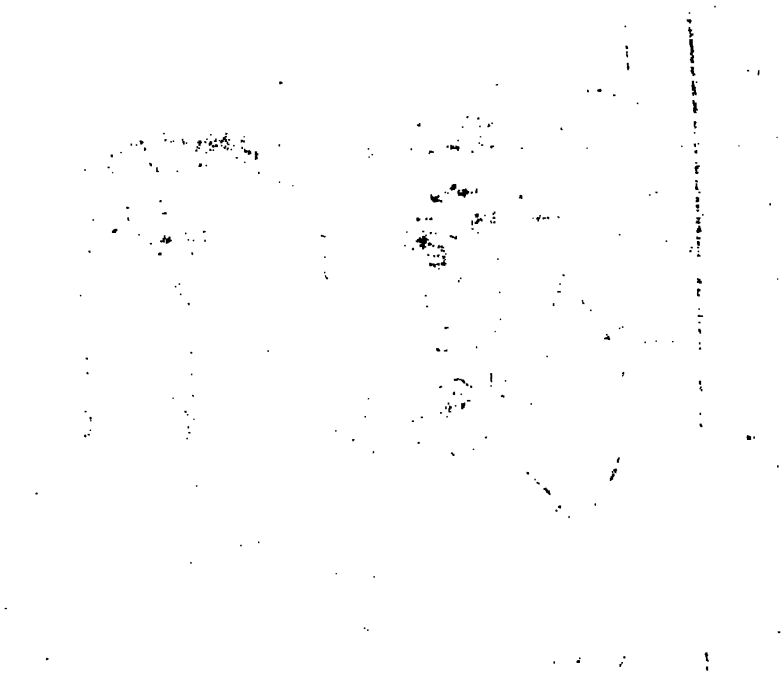
Diagramatic Illustration of the Westingl
Quick-Action Automatic Brake.—*Oppc*

PLATE G 2.

Westinghouse-American Locomotive and T
Equipment.—*Opposite.*

PLATE G 3.

Westinghouse Standard Passenger Car Brak
Signal Equipment.—*Opposite.*



UNCLASSIFIED

DETAILS OF SIX-INCH PUMP

PLATE B 6

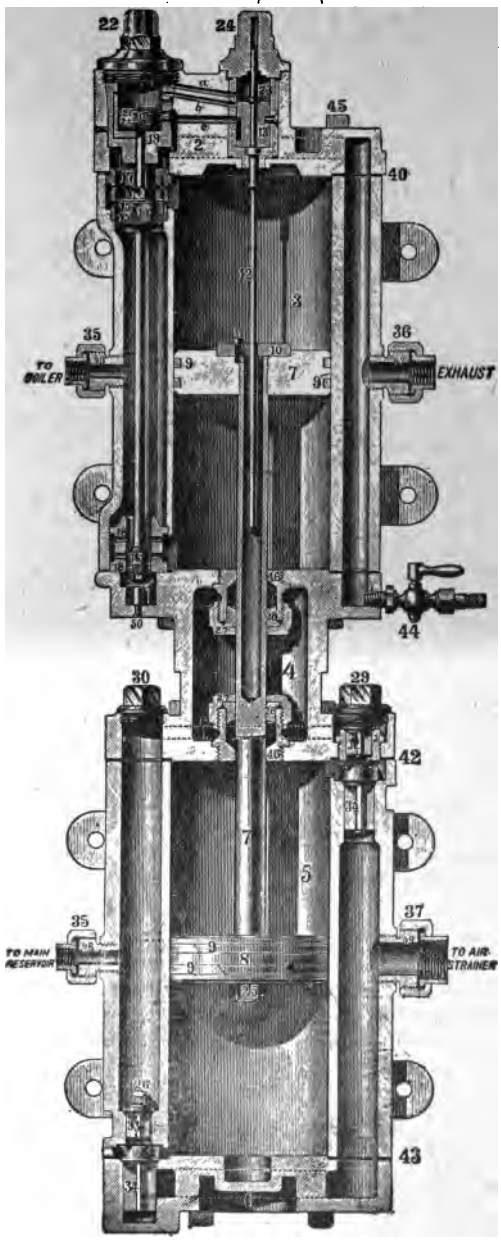
No.

1. Engine and Pump, complete. (No. 4, Plate B5.)
2. Steam-cylinder Head (with Reversing-cylinder, Piston, and Valve Bushes).
3. Steam-cylinder (with Main Valve and Bushes)
4. Center-piece.
5. Air-cylinder (with Lower Discharge-valve).
6. Air-cylinder Head.
7. Steam-piston and Rod.
8. Air-piston.
9. Main Piston Packing-ring.
10. Reversing-valve Plate.
11. Reversing-valve Plate Bolt.
12. Reversing-valve Stem.
13. Reversing-valve.
14. Main Steam-valve.
15. Packing-ring for Upper Piston-valve.
16. Packing-ring for Lower Piston-valve.
17. Upper Main Steam-valve Bush.
18. Lower Main Steam-valve Bush.
19. Reversing-cylinder.
20. Reversing-piston.
21. Reversing-piston Packing-ring.

No.

22. Reversing-cylinder cap.
23. Reversing-valve Bush.
24. Reversing-valve Cap.
25. Piston-rod Nut.
26. Discharge-valve Stop-bolt.
27. Piston-Packing Nut.
28. Piston-packing Gland.
29. Right Chamber Cap.
30. Left Chamber Cap.
31. Discharge-valve Seat.
32. Upper Discharge-valve.
33. Lower Discharge-valve.
34. Receiving-valve.
35. Half-inch Union.
36. Three-quarter-inch Union.
37. One-inch Union.
40. Top Steam-cylinder Gasket.
41. Bottom Steam-cylinder Gasket.
42. Top Air-cylinder Gasket.
43. Bottom Air-cylinder Gasket.
44. Drain Cock.
45. Cap Screw.
46. Packing Case.
47. Exhaust Union Stud.
48. Steam-pipe Union Stud.
49. Air-pipe Union Stud
50. Main-valve Stop.

PLATE B 6


22
24
45
40
2
3
35
36
TO BOILER
19
7
EXHAUST
44
30
4
23
42
7
5
37
35
TO MAIN RESERVOIR
9
8
TO AIR STRAINER
25
43

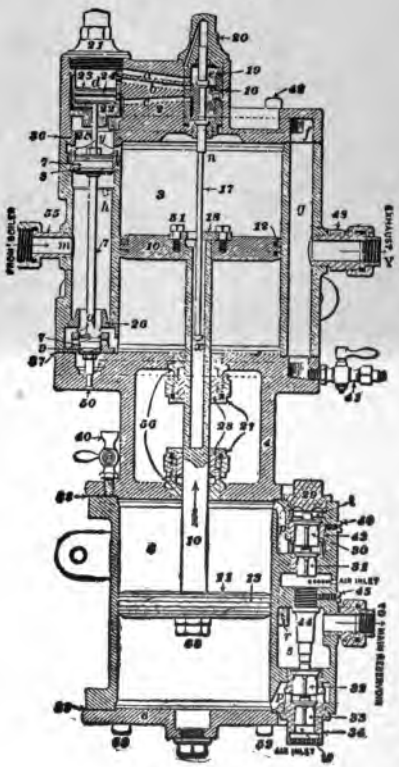
NAMES OF PARTS OF EIGHT-INCH AIR-PUMP

PLATE F 5.

No.	
1.	Eight-inch Pump, complete. (No. 5, Plate B5.)
2.	Top Head, with Reversing-cylinder, Piston, and Valve Bushes.
3.	Steam-cylinder, with Main Valve and Bushes.
4.	Center-piece.
5.	Air-cylinder Body, with Valves.
6.	Air-cylinder Head.
7.	Main Valve.
8.	Upper Main Valve Packing-ring.
9.	Lower Main Valve Packing-ring.
10.	Steam Piston and Rod.
11.	Air-piston.
12.	Steam-piston Packing-ring.
13.	Air-piston Packing-ring.
14.	Steam-pipe Union.
15.	Exhaust-pipe Union.
16.	Reversing-valve.
17.	Reversing-valve Stem.
18.	Reversing-valve Plate.
19.	Reversing-valve Bush.
20.	Reversing-valve Chamber Cap.
21.	Reversing-cylinder Cap.
22.	Reversing cylinder.
23.	Reversing-piston.
24.	Reversing-piston Packing-ring.
25.	Upper Main Valve Bush.
26.	Lower Main Valve Bush.
27.	Packing-nut.
28.	Packing-gland.
29.	Upper-valve Chamber Cap.
30.	Upper Discharge Valve.
31.	Upper Receiving-valve.
32.	Lower Discharge Valve.
33.	Lower Receiving-valve.
34.	Lower-valve Chamber Cap.
35.	Reservoir Union.
36.	Upper Steam-cylinder Gasket.
37.	Lower Steam-cylinder Gasket.
38.	Upper Air-cylinder Gasket.
39.	Lower Air-cylinder Gasket.
40.	Air-cylinder Oil-cup.
41.	Drain Cock.
42.	Cylinder-head Bolt.
43.	Valve Chamber Bush.
44.	Discharge Valve Stop.
45.	Valve Stop Set Screw.
46.	Chamber Bush Set Screw.
47.	Reservoir Union Stud.
48.	Exhaust-pipe Union Stud.
49.	Steam-pipe Union Stud.
50.	Main Valve Stop.
51.	Reversing-valve Plate Bolt.

PLATE F 5

8-INCH PUMP.



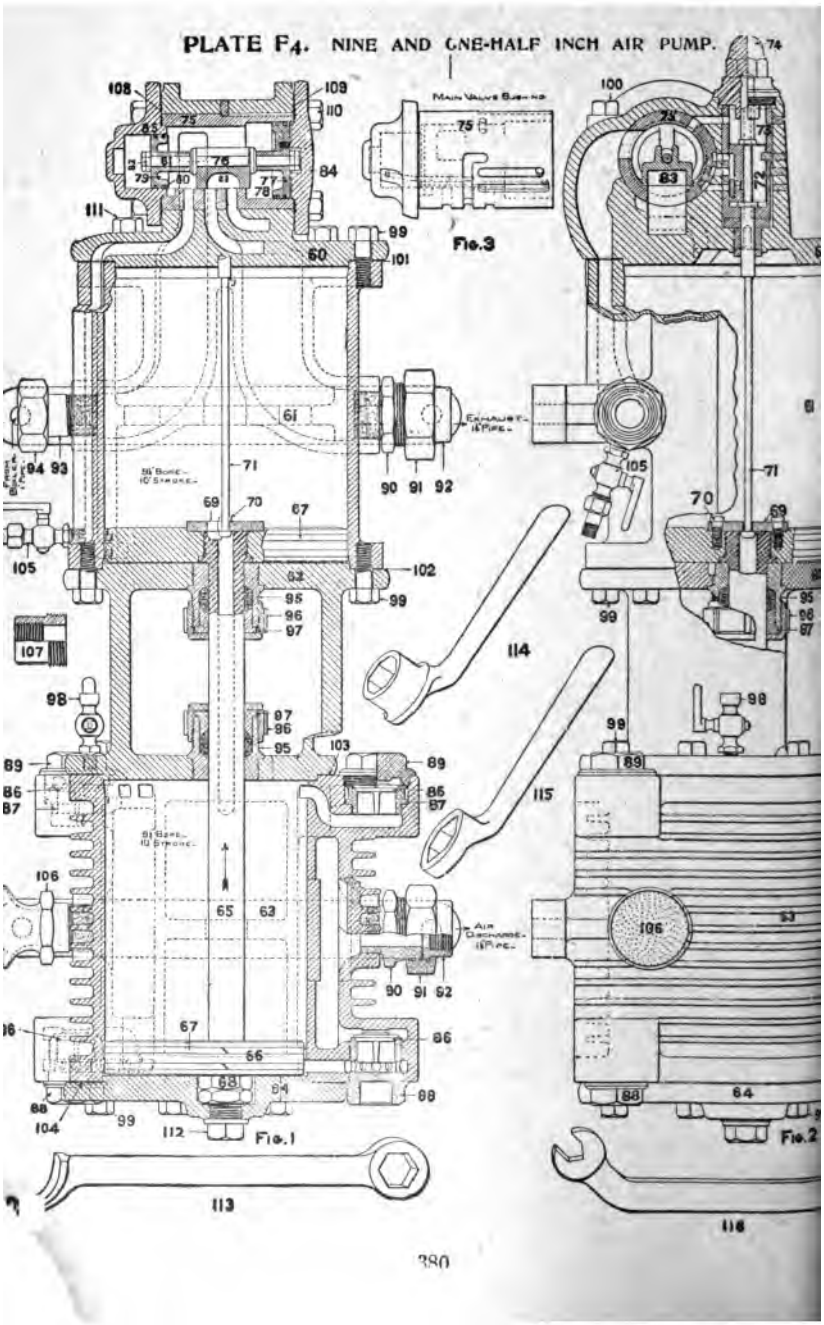


PLATE F4. NINE AND ONE-HALF INCH AIR PUMP.
Fig.3
Fig.1
Fig.2
Main Valve Bushing
Exhaust Pipe
Air Discharge Pipe
9½ Bore
10 Stroke

PLATE F 4.

NINE AND ONE-HALF INCH AIR PUMP

No. 1. Nine and One-Half inch Air Pump, complete.—

No.	
60.	Top Head, complete (includes one each of Nos. 72, 73, 74, 75, 76, 83, 84, 85, 108, and 109, and 8 of No. 110)
61.	Steam Cylinder, complete (includes one each of Nos. 90, 91, 92, 93 and 94, and 2 of No 105)
62.	Center Piece, complete (includes 2 each of Nos. 95, 96, and 97, and one of No. 98).
63.	Air Cylinder, complete (includes 4 of No. 86, 2 each of Nos. 87, 88, and 89, and one each of Nos 90, 91, 92, and 106).
64.	Lower Head.
65.	Steam Piston and Rod (includes 2 each of Nos. 67, 68, and 70, and one of No. 69).
66.	Air Piston, complete (includes 2 of No. 67).
67.	Piston Packing Ring
68.	Piston-Rod Nut
69.	Reversing-Valve Plate
70.	Reversing-Valve-Plate Bolt
71.	Reversing-Valve Rod.
72.	Reversing Valve.
73.	Reversing-Valve-Chamber Bush.
74.	Reversing-Valve-Chamber Cap.
75.	Main-Valve Bush.
76.	Main Valve, complete (includes Nos. 77, 79, and 81, and 4 of No 82).
77.	Large Main-Valve Piston (includes 2 of No. 78).
78.	Large Main-Valve-Piston Packing Ring
79.	Small Main-Valve Piston (includes 2 of No. 80).
80.	Small Main-Valve-Piston Packing Ring.
81.	Main-Valve Stem.
82.	Main-Valve-Stem Nut.
83.	Main Slide Valve.
84.	Right Main-Valve Cylinder Head.
85	Left Main-Valve Cylinder Head.
86.	Air Valve.
87.	Air-Valve Seat.
88.	Air-Valve Cage.
89.	Valve-Chamber Cap.
90.	One and One-fourth inch Union Stud.
91	One and One-fourth inch Union Nut.
92.	One and One-fourth inch Union Swivel.
93	One-inch Steam-Pipe Stud.
94.	Governor Union Nut.
95.	Stuffing Box.
96.	Stuffing-Box Nut
97.	Stuffing-Box Gland.
98.	Air-Cylinder Oil Cup.
99	Short Cap Screw (⅜"x1⅜")
100	Long Cap Screw (⅜"x6¼")
101	Upper Steam-Cylinder Gasket
102.	Lower Steam-Cylinder Gasket
103	Upper Air-Cylinder Gasket
104	Lower Air-Cylinder Gasket.
105	Drain Cock.
106	Air Strainer.
107.	One-inch Steam-Pipe Sleeve
108	Left Main-Valve-Head Gasket
109	Right Main-Valve-Head Gasket
110	Main-Valve-Head Bolt (⅜"x1¼")
111	Cap Screw (⅜"x2").
112	Cylinder-Head Plug.
113.	Packing and Cap-Nut Wrench
114.	Air-Valve-Seat Wrench.
115	Air-Valve-Cage Wrench
116.	Cap-Screw Wrench.

The accompanying cut illustrates the Standard 9 1/2-inch Air Pump, which is usually located on the right side of the locomotive. A special "Left-hand 9 1/2-inch Air Pump" is also manufactured As its name indicates, it is designed for installation on the left side of the locomotive; but all its parts are interchangeable with those of the Standard Pump, and its steam and exhaust-pipe connections have been so arranged that it can be substituted for the same and used on the right side if desired.

PLATE G5.

ELEVEN-INCH AIR PUMP.

No. 3679. Eleven-inch Air Pump, complete.

Piece No.	
3648	Top Head, complete (includes one each of Nos. 1706, 1700, 1701, 1710, 1595, 3647, 1707, 5169, 1599, 1715, 1716, and 10 of No. 1759).
3649	Steam Cylinder, complete (includes one each of Nos. 2682, 2684, 1900, 3682, 1887, 2683, 3315, 1885, and 1886).
3650	Center Piece, complete (includes 2 each of Nos. 1702, 1704, 1703, and 1887, and one of No. 1916).
3653	Air Cylinder, complete (includes 4 of No. 1705, 2 each of Nos. 4795, 1708, and 3652, and one each of Nos. 1882, 1883, 1884, and 2494).
5170	Lower Head (includes No. 1919).
3654	Steam Piston and Rod (includes one each of Nos. 1590, 1591, 1589, and 1688, 2 of No 1687, and 3 of No. 1689).
3680	Air Piston, complete (includes 2 of No. 1687).
1687	Piston Packing Ring.
1590	Piston-Rod Nut.
1591	Piston-Rod Jam Nut.
1589	Piston-Rod Cotter Pin.
1688	Reversing-Valve Plate
1689	Reversing-Valve-Plate Cap Screw
1709	Reversing-Valve Rod.
1706	Reversing Valve.
1700	Reversing-Valve-Chamber Bush
1701	Reversing-Valve-Chamber Valve-Stem Bush
1710	Reversing-Valve-Chamber Cap
1595	Main-Valve Bush.
3647	Main Valve, complete (includes one each of Nos. 3645, 1696, and 3646, and 4 of No 2052).
3645	Large Main-Valve Piston (includes 2 of No 1695)
1695	Large Main-Valve-Piston Packing Ring.
3646	Small Main-Valve Piston (includes 2 of No. 1694)
1694	Small Main-Valve-Piston Packing Ring.
1696	Main-Valve Stem

Piece No.	
2052	Main-Valve-Stem Nut.
1707	Main Slide Valve.
1599	Right Main-Valve Cylinder Head.
5169	Left Main-Valve Cylinder Head.
1705	Air Valve.
4795	Air-Valve Seat.
1708	Air-Valve Cage.
3652	Valve-Chamber Cap.
2682	Steam-Exhaust Stud.
2684	Steam-Exhaust Union Nut.
2683	Steam-Exhaust Union Swivel.
3315	Pipe Bushing ($1\frac{1}{4}$"x$1\frac{1}{4}$").
1885	One-inch Steam-Pipe Stud.
1886	Governor Union Nut.
1882	Air-Discharge Stud.
1883	Air-Discharge Union Nut.
1884	Air-Discharge Union Swivel.
1702	Stuffing Box.
1704	Stuffing-Box Nut.
1703	Stuffing-Box Gland.
1916	Air-Cylinder Oil Cup.
3661	Short Tee-Head Bolt ($\frac{3}{4}$"x$2\frac{1}{2}$") and Hexagon Nut.
3662	Long Tee-Head Bolt ($\frac{3}{4}$"x$3\frac{1}{2}$") and Hexagon Nut.
1711	Upper Steam-Cylinder Gasket.
1712	Lower Steam-Cylinder Gasket
1713	Upper Air-Cylinder Gasket.
1714	Lower Air-Cylinder Gasket.
1887	Drain Cock.
2494	Air Strainer.
1950	One-inch Steam-Pipe Sleeve.
1715	Left Main-Valve-Head Gasket.
1716	Right Main-Valve-Head Gasket.
1759	Main-Valve-Head Cap Screw ($\frac{3}{8}$"x$1\frac{1}{4}$").
1919	Cylinder-Head Plug.
2482	Packing and Cap-Nut Wrench.
2485	Air-Valve-Seat Wrench.
2483	Air-Valve-Cage Wrench.
2481	Wrench for Nuts on Tee-Head Bolts.
3269	Short Cap Screw ($\frac{3}{4}$"x2").
3270	Long Cap Screw ($\frac{3}{4}$"x$2\frac{1}{2}$").
1900	One and One-half-inch Pipe Plug.
3682	Two-inch Pipe Plug.
2680	Piston Swab
1898	Jacket-Band Screws ($\frac{5}{16}$"x$\frac{7}{16}$")
4862	Piston-Rod Packing (Vulcabeston)

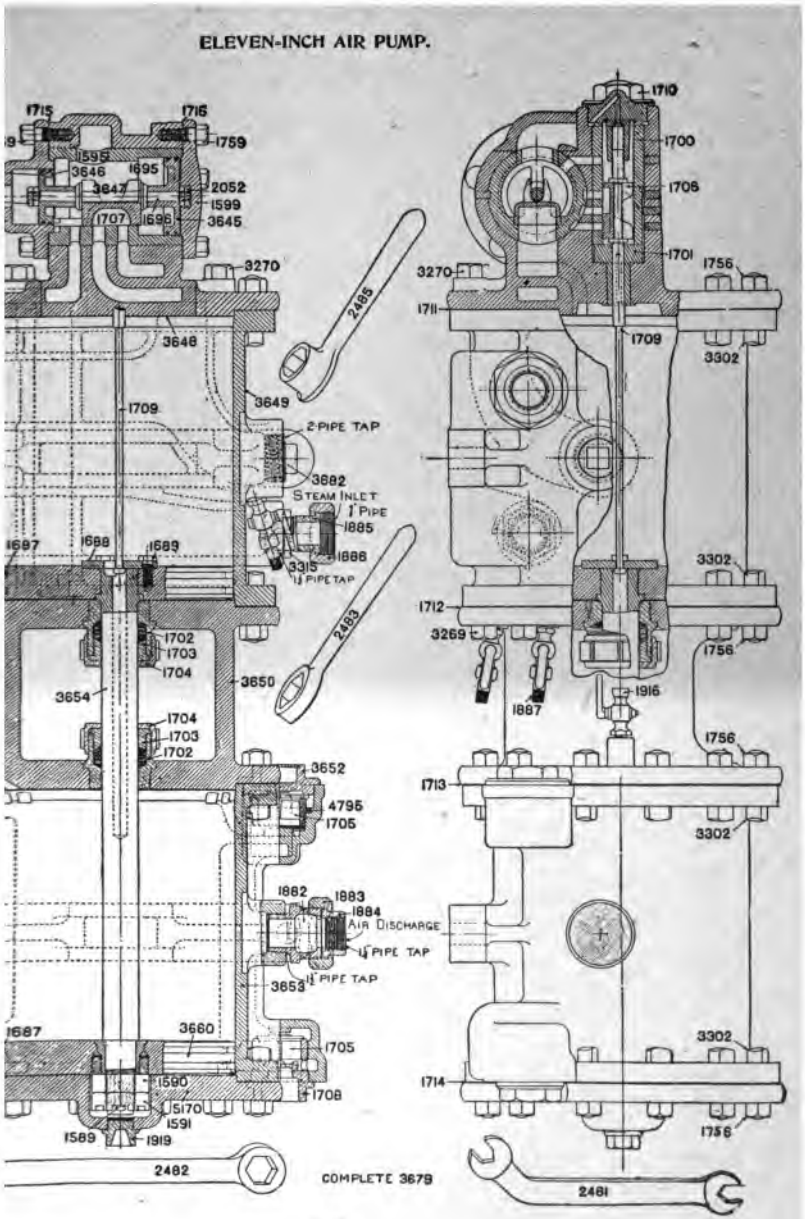
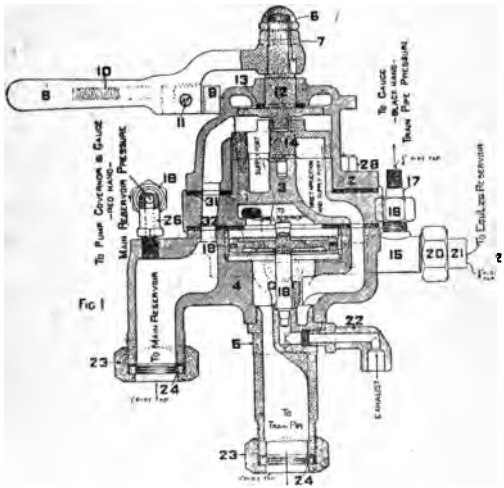
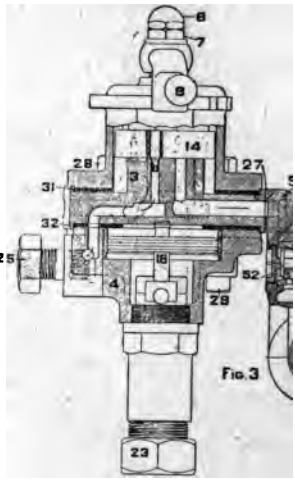
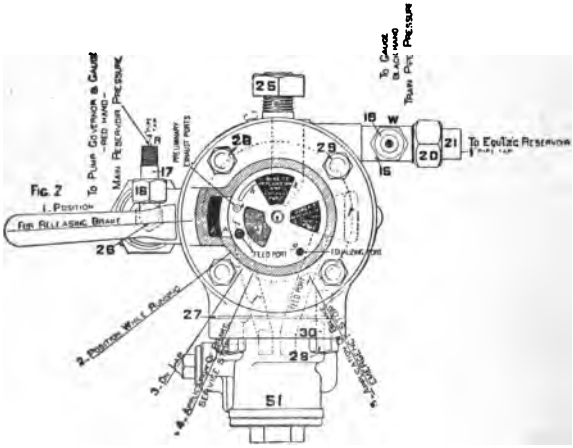

ELEVEN-INCH AIR PUMP.
1715
1716
1759
1595
3646
1695
3647
2052
1599
1707
1698
3645
3270
3648
1709
3649
2485
2 PIPE TAP
3682
STEAM INLET
1 PIPE
1885
1886
3315
1/4 PIPE TAP
2483
1697
1698
1689
1702
1703
1704
3650
3654
1704
1703
1702
3652
4795
1705
1882
1883
1884
AIR DISCHARGE
1/4 PIPE TAP
1/4 PIPE TAP
3653
1687
3660
1705
1590
1708
1570
1591
1589
1919
2482
COMPLETE 3679
1710
1700
1708
1701
1756
3270
1711
1709
3302
3302
1712
3269
1756
1916
1887
1756
1713
3302
3302
1714
1756
2481

PLATE G 6.

ENGINEER'S BRAKE VALVE.







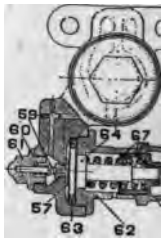


Fig. 4.

PLATE G 6.

ENGINEER'S BRAKE VALVE.

). Brake Valve with Slide-Valve Feed Ve . One-Inch Cut-out Cock (Fig. 6 Plate G 32), and Equalizing Reservoir (. 4, Plate G 23) Complete.

Brake Valve proper (without Feed-Valve Attachment), covers Nos. 2 to 32, inclusive.

No.	
	alve Body.
	otary-Valve Seat.
	ottom Case.
	ottom Cap.
	am Nut.
	op Nut.
	andle (includes Nos. 9, 10, and 11).
	andle Bolt.
	andle-Bolt Spring.
	andle-Bolt Screw.
	otary-Valve Key.
	asher.
	otary Valve.
	auge-Pipe Tee.
	ne-fourth inch Union Nut.
	ne-fourth inch Union Swivel.
18.	Piston Valve (includes No. 19).
19.	Piston Ring.
20.	Three-eighths inch Union Nut.
21.	Three-eighths inch Union Swivel
22.	Exhaust-Pipe Fitting
23.	One-inch Union Nut
24.	One-inch Union Swivel.
25.	Holding Nut.
26.	Gauge-Pipe Fitting.
27.	Feed-Valve-Case Gasket.
28.	Half-inch Nut.
29.	Half-inch Bolt.
30.	Feed-Valve Stud.
31.	Upper Gasket.
32.	Lower Gasket.

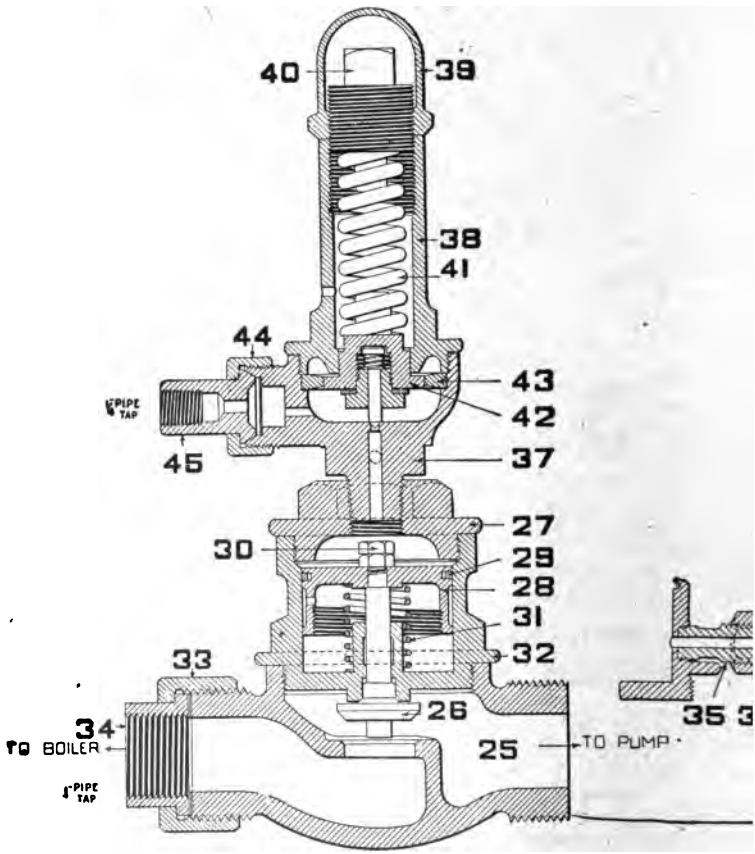
50. Slide-Valve Feed Valve, complete; covers Nos. 51 to 67, inclusive.

	eed-Valve Body (bushed).
	ush Nut.
	ip Nut.
	ipply-Valve Piston.
	ipply Valve.
	ipply-Valve Spring.
	aphragm (2 pieces).
	ipply-Valve-Piston Spring.
	gulating Valve.
60.	Regulating-Valve Spring.
61.	Regulating-Valve Cap Nut.
62.	Spring Box.
63.	Diaphragm Ring.
64.	Diaphragm Spindle.
65.	Regulating Nut.
66.	Check Nut.
67.	Regulating Spring.

PLATE F7.

ONE-INCH PUMP GOVERNOR.

STANDARD FOR NINE AND ONE-HALF INCH PUMP



NOTE—When used in conjunction with an Engineer's Brake Valve having a Feed Valve most instances, the Pump Governor should be piped to the Main Reservoir Connection at the Valve, as indicated on Plates "F 6" and "G 6", when an Excess-Pressure Valve is used in plac Feed Valve, however, the Governor is actuated by Train Line Pressure, and should be piped to Line accordingly.

PLATE F 7

ONE-INCH PUMP GOVERNOR.

No. 1. One-inch Pump Governor, complete.

No.	
25.	Steam-Valve Body.
26.	Steam Valve.
27.	Cylinder Cap.
28.	Governor Piston (includes No. 29).
29.	Piston Packing Ring.
30.	Governor-Piston Nut.
31.	Governor-Piston Spring.
32.	Steam-Valve Cylinder (includes Nos. 35 and 36).
33.	One-inch Union Nut.
34.	One-inch Union Swivel.
35.	Waste-Pipe Stud.
36.	Waste-Pipe Union Nut.
37.	Diaphragm Body.
38.	Spring Box.
39.	Cap Nut.
40.	Regulating Nut.
41.	Regulating Spring.
42.	Diaphragm, complete.
43.	Diaphragm Ring.
44.	Union Nut.
45.	Union Swivel.

PLATE G9. DETAIL PARTS OF ENGINE AND TENDER BRAKE APPARATUS.

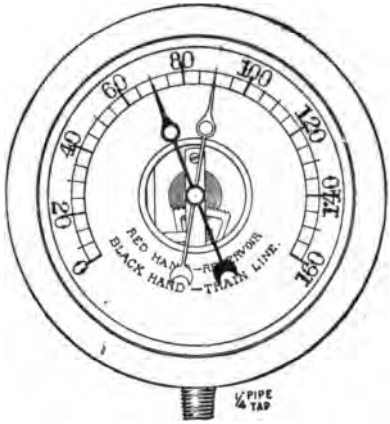


Fig. 1.

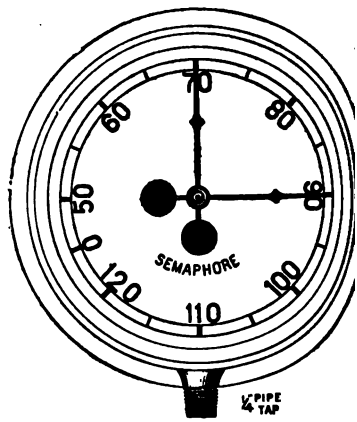


Fig. 2.

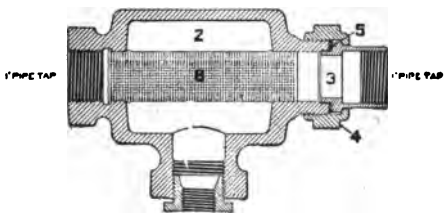


Fig. 3.

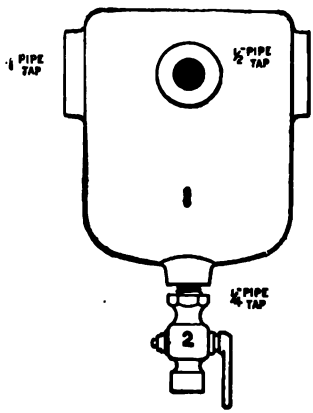


Fig. 6.

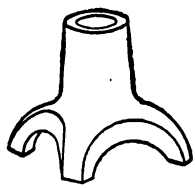


Fig. 5.

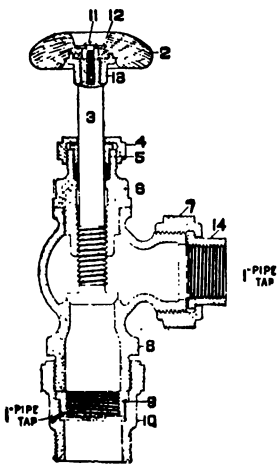


Fig. 4.

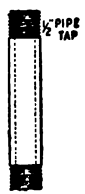


Fig. 7.

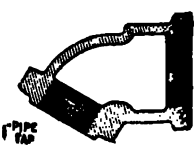


Fig. 8.

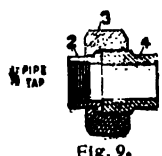


Fig. 9.

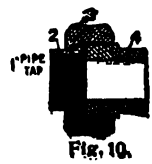


Fig. 10.

PLATE G 9.

DETAIL PARTS OF ENGINE AND TENDER BRAKE APPARATUS.

FIG. 1.

ndard Duplex Air Gauge.

FIG. 2.

naphore Air Gauge.

FIG. 3.

e-inch by One-half inch Brake-Pipe Air Strainer, complete.

rainer Body.
ıe-inch Union Swivel.
nion Nut.
nion Gasket.
rainer.

FIG. 4.

e-inch Steam Valve, complete.

and Wheel.
alve Stem.
ıcking Nut.
ıcking Gland.
ɔck Piece.
nion Nut.
alve Body.
nion Swivel.*
alve Stud.*
and-Wheel Screw
and-Wheel Washer
and-Wheel Socket.
eam-Pipe Swivel.

FIG. 5.

'lain Triple-Valve Bracket.

FIG. 6.

Tender Drain Cup, complete.

No.
1. Tender Drain Cup.
2. Tender Drain Cock.

FIG. 7.

Plain Triple-Valve Nipple.

FIG. 8.

One-inch by One and One-fourth inch Angle Fitting.

FIG. 9.

Three-fourths inch Reservoir Union, complete.

No.
2. Union Swivel.
3. Union Nut.
4. Union Stud.

FIG. 10.

One-inch Reservoir Union complete.

No.
2. Union Swivel.
3. Union Nut.
4. Union Stud.

FIG. 11.

One and One-fourth inch Reservoir Union, complete.

No.
2. Union Swivel.
3. Union Nut.
4. Union Stud.

PLATE G 14.

PRESSURE HEADS FOR BRAKE CYLINDERS.

Fig. 1.

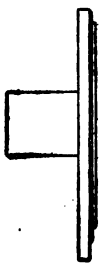


Fig. 2.

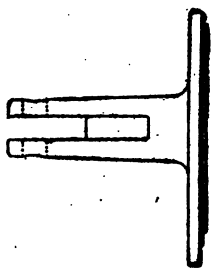


Fig. 3.

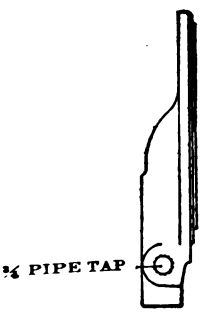


Fig. 4.

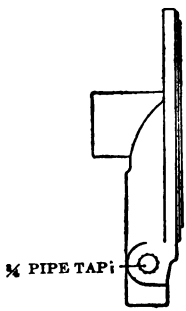


Fig. 5.

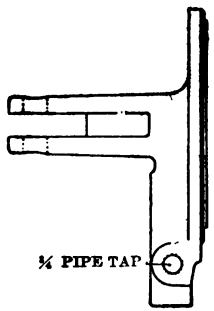


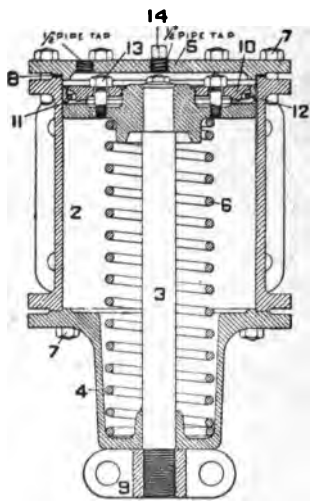
Fig. 6.

EXPLANATION OF TYPES ILLUSTRATED.

Fig. 1. Type O—Plain Head.
Fig. 2. Type P—Plain Head with Slack Adjuster Lug.
Fig. 3. Type Q—Bracket Head.
Fig. 4. Type R—Quick-Action Triple Valve Head.
Fig. 5. Type S—Quick-Action Triple Valve Head with Slack Adjuster Lug.
Fig. 6. Type T—Quick-Action Triple Valve Head with Bracket.

PLATE F15.

STANDARD PUSH-DOWN TYPE DRIVER-BRAKE CYLINDERS.



OUTER FLANGES FULL.

Cylinder No.	Diameter.		Stroke.
11	8 in.	x	7 in.
13	12 "	x	8 "
15	12 "	x	10 "
30	10 "	x	6 "
33	8 "	x	6 "
35	10 "	x	10 "
39	12 "	x	12 "
42	14 "	x	12 "
47	16 "	x	12 "
48	6 "	x	8 "
49	12 "	x	7 "
50	13 "	x	12 "
51	10 "	x	6 "
55	10 "	x	8 "
66	6 "	x	6 "
99	10 "	x	12 "

OUTER FLANGES REMOVED.

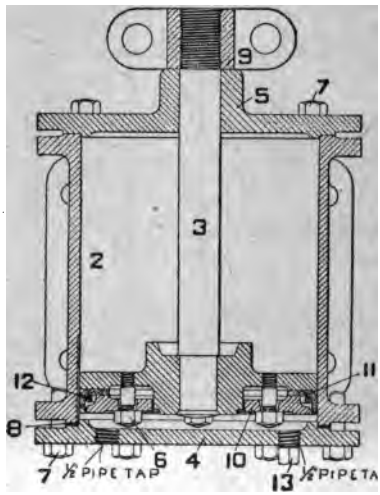
Cylinder No.	Diameter.		Stroke.
22	8 in.	x	7 in.
31	10 "	x	6 "
36	10 "	x	10 "
40	12 "	x	12 "
44	8 "	x	6 "
77	6 "	x	6 "
88	10 "	x	8 "

No.
2. Cylinder Body.
3. Piston and Rod (includes Follower Studs and Nuts).
4. Non-Pressure Head.
5. Pressure Head.
6. Release Spring.
7. Cylinder-Head Bolt and Nut.
8. Cylinder Gasket.

No.
9. Cross Head (select kind desired from Plate F 22).
10. Follower.
11 Packing Leather.
12. Packing Expander.
13. Follower Stud and Nut.
14. Oil Plug.

PLATE F 17.

STANDARD PUSH-UP TYPE DRIVER-BRAKE CYLINDERS.



OUTER FLANGES FULL.				OUTER FLANGES REMOVED.			
Cylinder No.	Diameter.		Stroke.	Cylinder No.	Diameter.		Stroke.
6	8 in.	x	7 in.	17	8 in.	x	7 in.
8	10 "	x	8 "	19	10 "	x	8 "
3	12 "	x	10 "				
6	12 "	x	8 "				

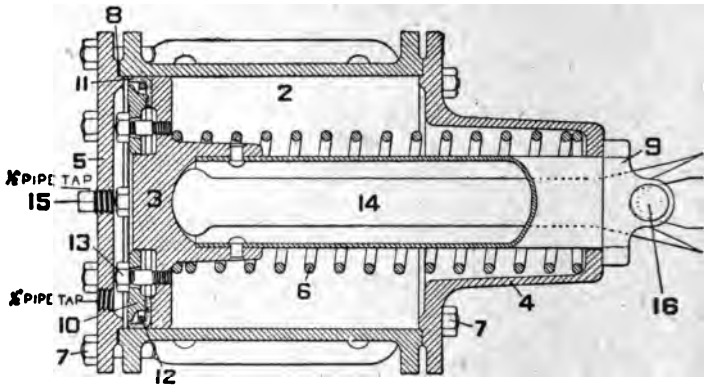
No.

Cylinder Body.
Piston and Rod (includes Follower Studs and Nuts).
Pressure Head.
Non-Pressure Head.
Follower Stud and Nut.
Cylinder-Head Bolt and Nut.

8. Cylinder Gasket.
9. Cross Head (select kind desired from Plate F 22).
10. Follower.
11. Packing Leather.
12. Packing Expander.
13. Oil Plug.

PLATE F19.

STANDARD TYPE "B" PUSH DRIVER-BRAKE CYLINDERS.



OUTER FLANGES FULL.			
Cylinder No.	Diameter.		Stroke.
11-B	8 in.	x	7 in.
13-B	12 "	x	8 "
15-B	12 "	x	10 "
21-B	14 "	x	10 "
33-B	8 "	x	6 "
35-B	10 "	x	10 "
39-B	12 "	x	12 "
42-B	14 "	x	12 "
47-B	16 "	x	12 "
48-B	6 "	x	8 "
49-B	12 "	x	7 "
50-B	13 "	x	12 "
51-B	10 "	x	6 "
55-B	10 "	x	8 "
90-B	10 "	x	12 "

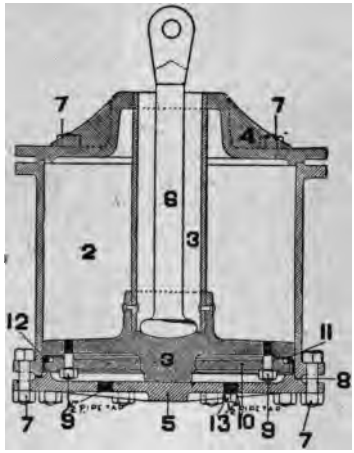
OUTER FLANGES REMOVE		
Cylinder No.	Diameter.	
22-B	8 in.	x
36-B	10 "	x
44-B	8 "	x
88-B	10 "	x

No.
2. Cylinder Body.
3. Piston and Rod (includes No. 9, and Follower Studs and Nuts).
4. Non-Pressure Head.
5. Pressure Head.
6. Release Spring.
7. Cylinder-Head Bolt and Nut.
8. Cylinder Gasket.
9. Push-Rod Holder.

No.
10. Follower.
11. Packing Leather.
12. Packing Expander.
13. Follower Stud and Nut.
14. Push Rod, complete (in Nos. 15 and 16).
15. Oil Plug.
16. Push-Rod-Holder Pin, with C
17. Push-Rod Pin, with Cotter.

PLATE P20.

STANDARD TYPE "C" PUSH DRIVER-BRAKE CYLINDERS.



OUTER FLANGES FULL.

Diameter.		Stroke.
8 in.	x	7 in.
12 "	x	8 "
12 "	x	10 "
14 "	x	10 "
10 "	x	6 "
8 "	x	6 "
10 "	x	10 "
12 "	x	12 "
14 "	x	12 "
10 "	x	8 "
10 "	x	12 "

OUTER FLANGES REMOVED.

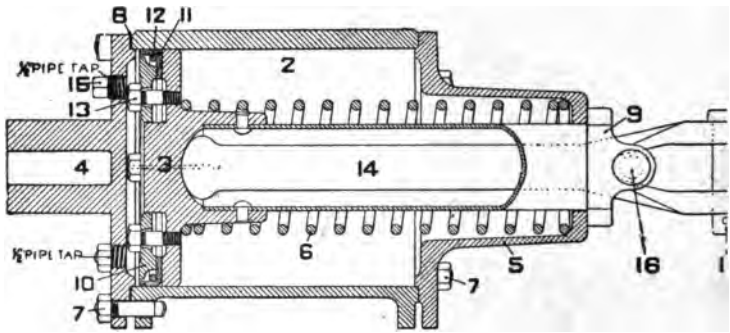
Cylinder No.	Diameter.		Stroke.
22-C	8 in.	x	7 in.
31-C	10 "	x	6 "
36-C	10 "	x	10 "
44-C	0 "	x	6 "
88-C	10 "	x	8 "

No.

1. Cylinder Body.
2. Piston and Rod (includes Follower Studs and Nuts).
3. Main-Pressure Head.
4. Pressure Head.
5. Push Rod, complete.
6. Cylinder-Head Bolt and Nut.
8. Cylinder Gasket.
9. Follower Stud and Nut.
10. Follower.
11. Packing Leather.
12. Packing Expander.
13. Oil Plug.

PLATE P 21.

STANDARD TYPE "D" ENGINE-TRUCK BRAKE CYLINDERS



Cylinder No.	Diameter.		Stroke.
11-D	8 in.	x	7 in.
35-D	10 "	x	10 "
43-D	8 "	x	12 "
48-D	6 "	x	8 "
49-D	12 "	x	7 "
55-D	10 "	x	8 "
66-D	6 "	x	6 "
99-D	10 "	x	12 "

No.

2. Cylinder Body.
3. Piston and Rod (includes No. 9, and Follower Studs and Nuts).
4. Pressure Head.
5. Non-Pressure Head.
6. Release Spring.
7. Cylinder-Head Bolt and Nut.
8. Cylinder Gasket.
9. Push-Rod Holder.

No.

10. Follower.
11. Packing Leather.
12. Packing Expander
13. Follower Stud and Nut.
14. Push Rod, complete (includes N 15 and 16).
15. Oil Plug.
16. Push-Rod-Holder Pin, with cott
17. Push-Rod Pin, with cotter.

PISTON CROSS HEADS FOR DRIVER-BRAKE CYLINDERS.

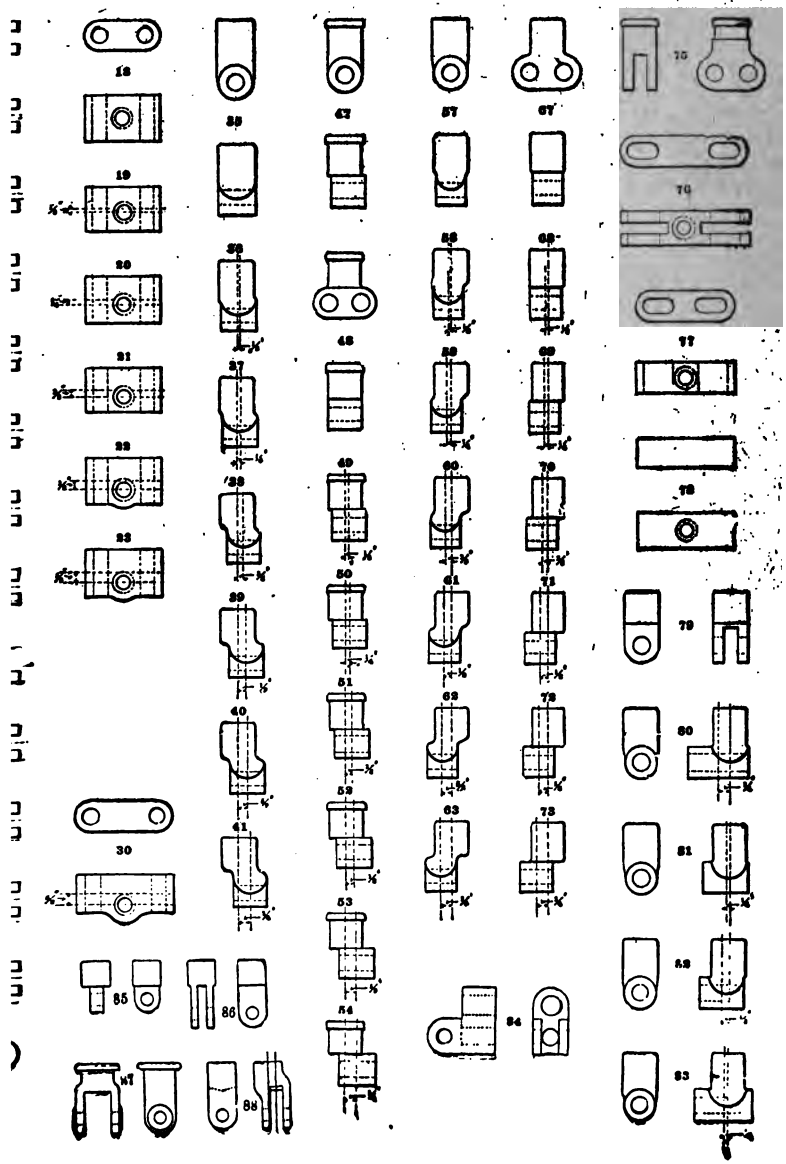


PLATE G23. RESERVOIRS

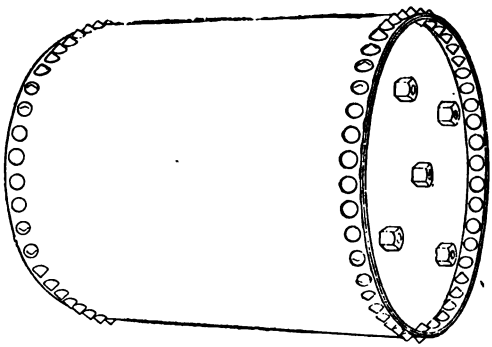


Fig. 1.

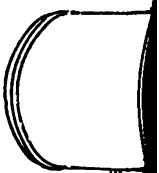


Fig. 4.

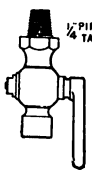


Fig. 5.

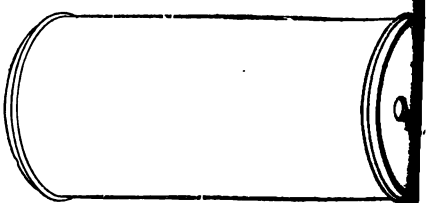


Fig. 2.

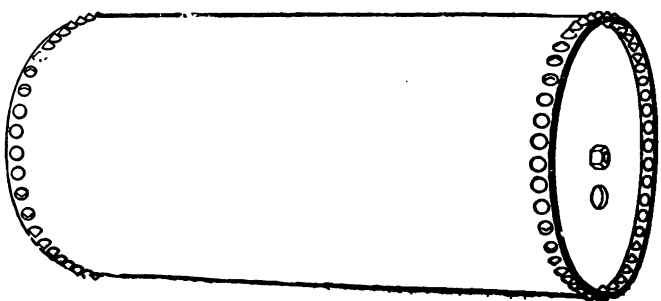


Fig. 3

PLATE G 23.

RESERVOIRS.

L. Main Reservoirs of the type illustrated, and of any desired length, are manufactured of the following standard diameters in inches, outside measurement; viz., 16, 18½, 20½, 22½, 24½, 26½, 28½, 30½, 32½, 34½, 36½. To ascertain approximate capacity in cubic inches, multiply the square of the inside diameter (which is ¼ inch less than the size specified) by .7854, and the product by the length, less an allowance of three inches to cover flanges.

Main Reservoir capacity for Passenger Engines should not be less than 20,000 cubic inches, and for Freight Engines, not less than 40,000 cubic inches.

L. Standard Auxiliary Reservoirs of the type illustrated are manufactured in the following sizes, and for use in connection with the Brake Cylinders specified:

10-in. by 24-in., for 8 in. Tender and Truck-Brake Cylinders.
10 " by 33 " " 8-in. Driver-Brake Cylinders.
12 " by 33 " " 10-in. Brake Cylinders of all kinds.
14 " by 33 " " 12-in. " " " "
16 " by 33 " " 14-in. " " " "

Auxiliary Reservoirs are tapped for pipe connections as follows 0-in. by 24-in., for ½-inch pipe, all others for ¾-inch pipe.

L. Special Auxiliary Reservoir of the type illustrated, 18½-in. by 41-in. For 16-inch Driver-Brake Cylinders. Tapped for ¾-inch pipe

L. Equalizing Reservoir, 10-in. by 12-in. For use in connection with Engineer's Brake Valve. Tapped for ¾-inch pipe.

L. Reservoir Drain Cock.

PLATE G 24. PLAIN TRIPLE VALVE.

FOR 8-INCH, AND 10-INCH CYLINDERS

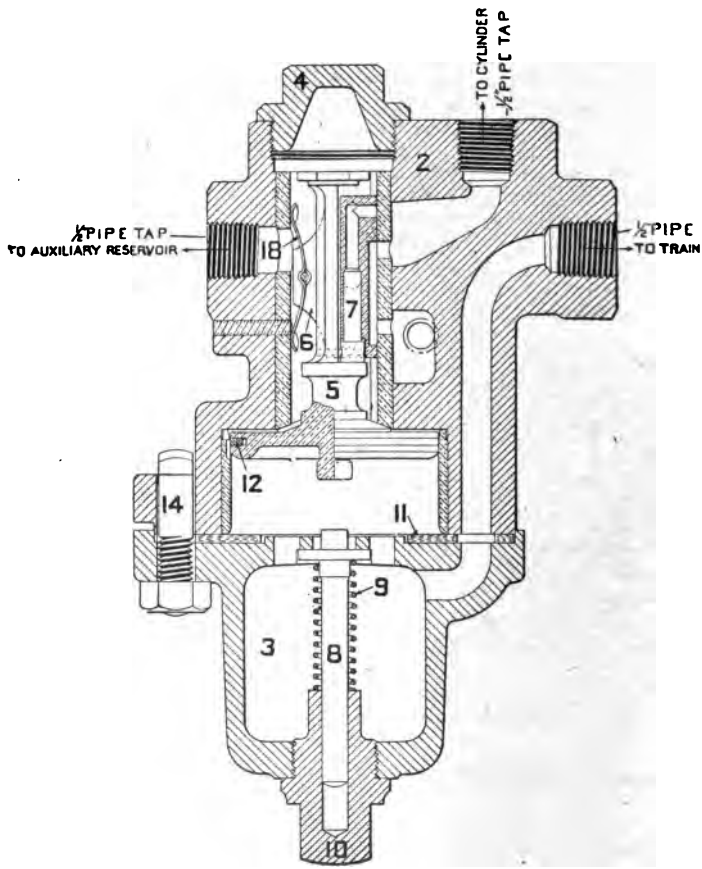


PLATE G 24.

PLAIN TRIPLE VALVE.

FOR 8-INCH, AND 10-INCH CYLINDERS.

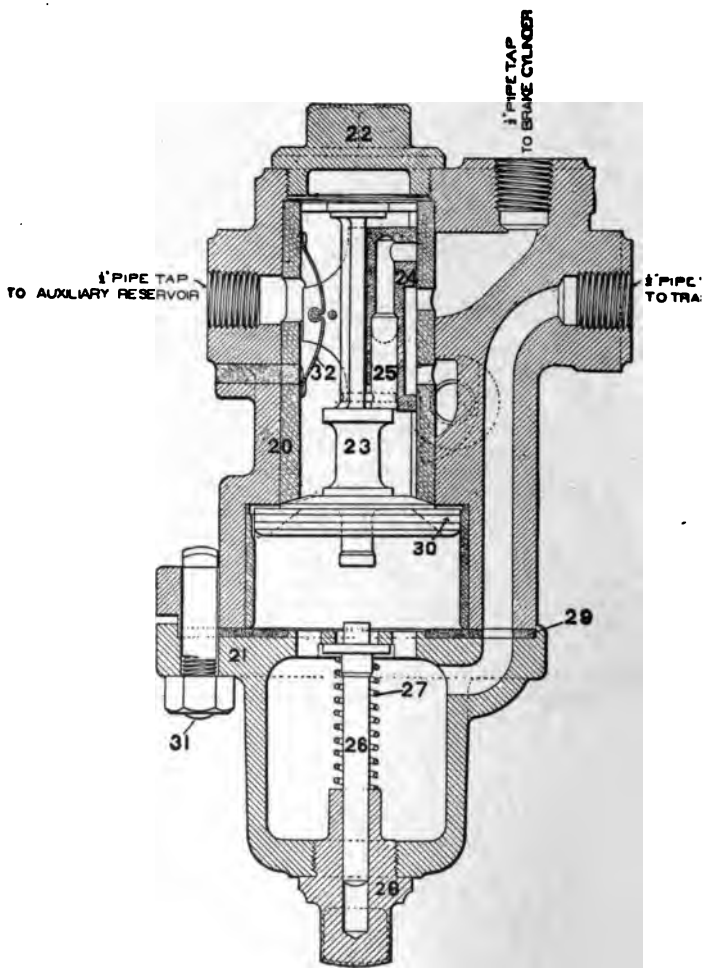
No. 1. "G 24" Plain Triple Valve, complete.

No.	
1.	Triple-Valve Body (bushed)
1.	Cylinder Cap.
1.	Cap Nut.
1.	Piston (includes No. 12)
1.	Slide Valve.
1.	Graduating Valve.
1.	Graduating Stem.
9.	*Graduating Spring.
10.	Graduating-Stem Nut.
11.	Cylinder Gasket.
12.	Packing Ring.
14.	Bolt.
18.	Slide-Valve Spring.

*GRADUATING SPRING SPECIFICATIONS. Phosphor-Bronze Spring Wire, No. 14 B. W. G. $\frac{1}{16}$ inches in diameter; 12 coils, 2 1/2 inches free height, $\frac{3}{4}$ inches inside diameter.

PLATE F 25. PLAIN TRIPLE VALVE.

FOR 12-INCH, 14-INCH, AND 16-INCH DRIVER-BRAKE CYLINDERS.



NOTE.—The "F 25" Plain Triple Valve should be used with 12-inch, 14-inch, and 16-i Driver-Brake Cylinders, with or without Truck Brake; and for no other purpose.

PLATE F 25.

PLAIN TRIPLE VALVE.

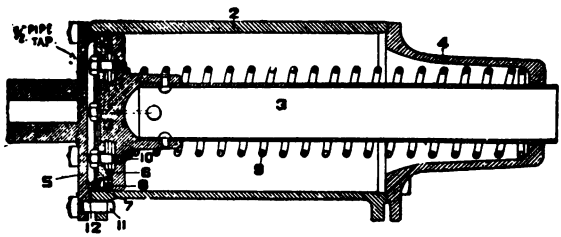
FOR 12-INCH, 14-INCH AND 16-INCH DRIVER-BRAKE CYLINDERS.

No. 1. "F 25" Plain Triple Valve, complete.

No.	
	Triple-Valve Body (bushed).
	Cylinder Cap.
	Cap Nut.
	Piston (includes No. 30).
	Slide Valve.
	Graduating Valve.
	Graduating Stem.
27.	Graduating Spring.
28.	Graduating-Stem Nut.
29.	Cylinder Gasket.
30.	Packing Ring.
31.	Bolt and Nut.
32.	Slide-Valve Spring.

PLATE G 26.

TENDER-BRAKE CYLINDERS.

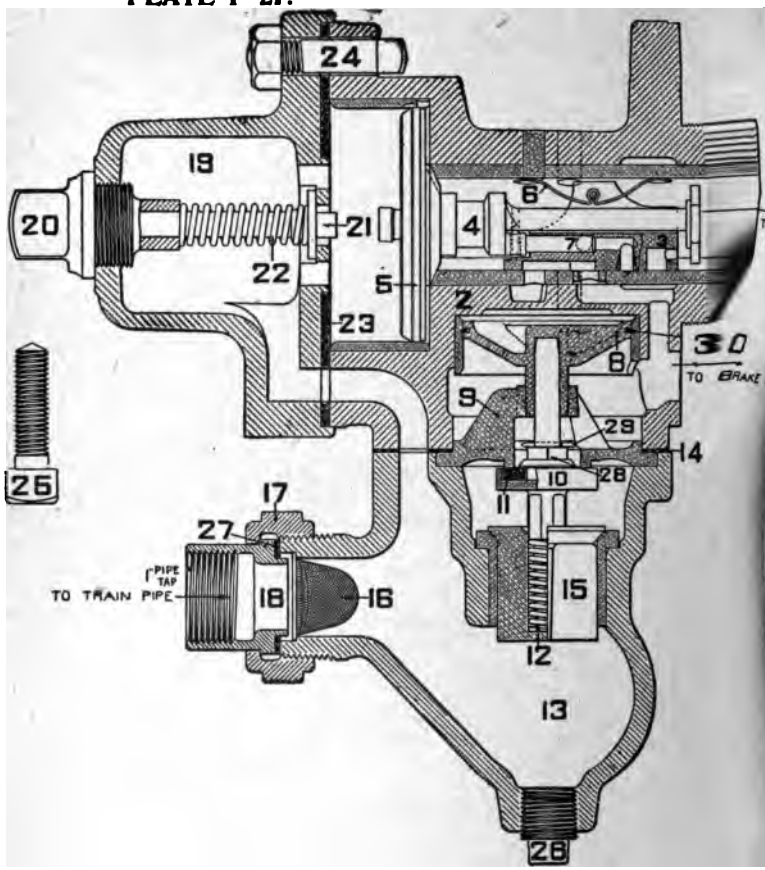


No. 1. Tender-Brake Cylinder, complete.

No.	
2.	Cylinder Body.
3.	Piston and Rod (includes Follower Studs and Nuts).
4.	Non-Pressure Head.
*5.	Pressure Head.
6.	Follower.
7.	Packing Leather.
8.	Packing Expander.
9.	Release Spring.
10.	Follower Stud and Nut.
11.	Cylinder-Head Bolt and Nut.
12.	Cylinder Gasket.

* NOTE.—For locomotive tenders, the light weight of which does not exceed 35,000 pounds, the 8-inch Tender-Brake Cylinder; for tenders of greater weight, use the 10-inch size. The style cylinder head, illustrated above, viz., "Plain Head, with Slack-adjuster Lug," is considered standard.

PLATE F 27. QUICK-ACTION PASSENGER TRIPLE VALVE.



NOTE.—The "F 27" Triple Valve should be used in connection with the following apparatus only:

Passenger-Car Brake Cylinders, 10 inches AND LESS in diameter;

High-Speed Tender-Brake Cylinders, 10 inches in diameter.

Though similar in appearance, this valve differs essentially from the "F 36," or Freight Triple Valve, and should never be employed in connection with Freight-Car Brakes. In common with the other Passenger Triple, "F 29," it may be distinguished from the Freight Triple by the fact that it has but one exhaust outlet while the "F 36" Valve has two. The three Quick-Action Triple-Valves may be identified also by the bore of the Slide-Valve Bush which measures 1 3/8 inches in the "F 27," 1 3/8 inches in the "F 29," and 1 1/4 inches in the "F 36" Valve.

PLATE F 27.

QUICK-ACTION PASSENGER TRIPLE VALVE.

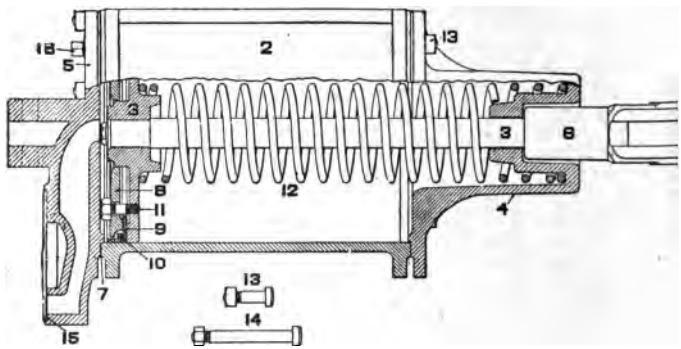
. 1. "F 27" Quick-Action Passenger Triple Valve, complete.

	No.	
Valve Body (bushed).	17.	Union Nut.
'alve.	18.	Union Swivel.
(includes No. 5).	19.	Cylinder Cap.
g Ring.	20.	Graduating-Stem Nut.
'alve Spring.	21.	Graduating Stem.
ting Valve.	22.	*Graduating Spring.
ency-Valve Piston.	23.	Cylinder-Cap Gasket.
ency-Valve Seat.	24.	Bolt and Nut.
ency Valve.	25.	Half-inch Cap Screw.
· Seat.	26.	Half-inch Plug.
Valve Spring.	27.	Union Gasket.
Valve Case (bushed).	28.	Emergency-Valve Nut.
Valve-Case Gasket.	29.	Cotter Pin.
Valve.	30.	Emergency-Valve Piston Packing Ring.
r		

ATING SPRING SPECIFICATIONS: Eight one hundredths ($\frac{8}{100}$) inches diameter. "Piano" Wire; 13 1/4 coils; 2 5/8 inches free height; $\frac{7}{8}$ inches inside diameter.

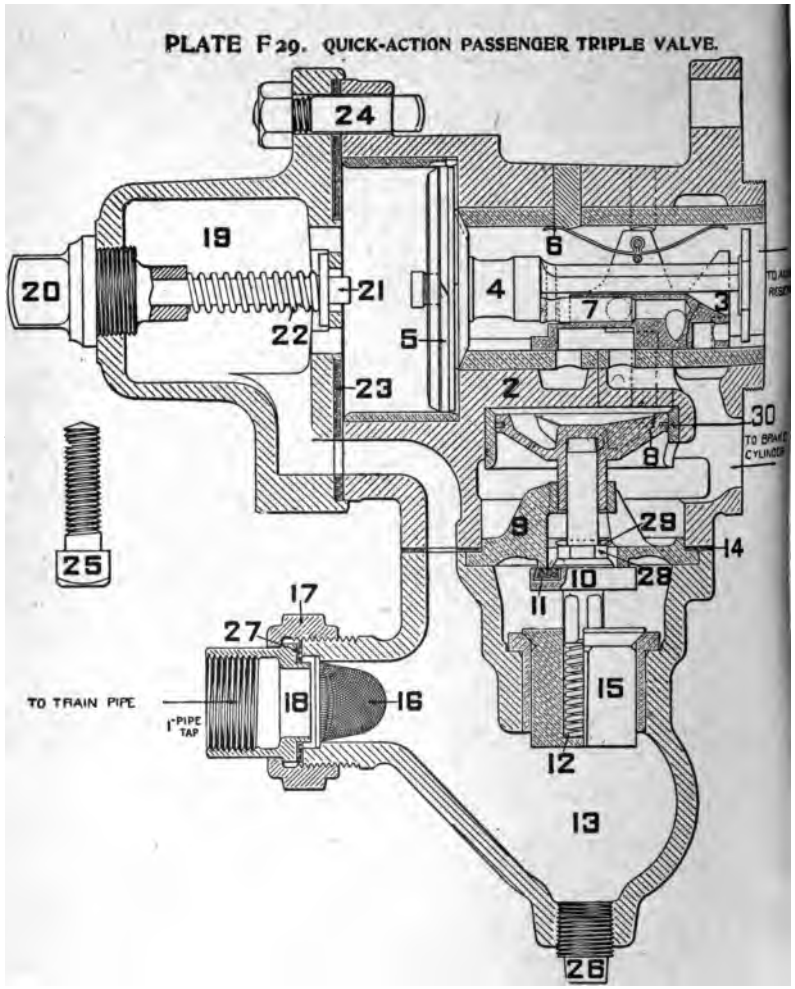
PLATE F28.

TEN-INCH PASSENGER-CAR BRAKE CYLINDERS.



No. 1. Ten-inch Passenger-Car Brake Cylinder, complete.

No.
2. Cylinder Body.
3. Piston and Rod (includes Follower Studs and Nuts).
4. Non-Pressure Head.
5. Pressure Head (includes 2 of No. 14).
6. Cross Head.
7. Cylinder Gasket.
8. Follower.
9. Packing Leather.
10. Packing Expander.
11. Follower Stud and Nut.
12. Release Spring.
13. Cylinder-Head Bolt and Nut.
14. Triple-Valve Bolt and Nut.
15. Triple-Valve Gasket.
16. Half-inch Plug.



NOTE.—The "F 29" Triple Valve should be used in connection with Passenger-Car Brake Cylinders, 12 and 14 inches in diameter.

Though similar in appearance this valve differs essentially from both the "F 27" and "F 36" Triples, and should never be employed except as specified. It may be easily recognized by means of the letter "O" cast on the valve body. In common with the other Passenger Triple, "F 27," it may be distinguished from the Freight Triple by the fact that it has but one exhaust outlet while the "F 36" valve has two. The three Quick-Action Triple-Valves may be identified also by the bore of the Slide Valve Bush which measures 1 3/8 inches in the "F 27," 1 3/4 inches in the "F 29," and 1 1/4 inches in the "F 36" Valve.

PLATE F29.

QUICK-ACTION PASSENGER TRIPLE VALVE.

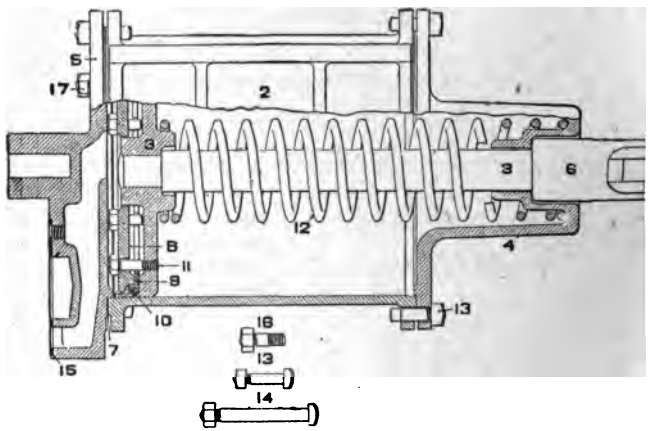
1. "F29" Quick-Action Passenger Triple Valve, complete.

No.	
	alve Body (bushed).
	lve.
	ncludes No. 5)
	Ring.
	lve Spring.
	ng Valve.
	cy-Valve Piston.
	cy-Valve Seat.
	cy Valve.
	Seat.
	alve Spring.
	alve Case (bushed).
	alve-Case Gasket.
	alve.
17.	Union Nut.
18	Union Swivel.
19.	Cylinder Cap.
20.	Graduating-Stem Nut.
21.	Graduating Stem.
22.	*Graduating Spring.
23.	Cylinder-Cap Gasket.
24.	Bolt and Nut.
25.	Half-inch Cap Screw.
26.	Half-inch Plug.
27.	Union Gasket.
28.	Emergency-Valve Nut.
29.	Cotter Pin.
30.	Emergency-Valve Piston Packing Ring.

TING SPRING SPECIFICATIONS: Eight one hundredths ($\frac{8}{100}$) inches diamete. Piano" Wire; 13 1/4 coils; 2 5/8 inches free height; $\frac{13}{16}$ inches inside diameter.

PLATE F 30.

TWELVE-INCH PASSENGER-CAR BRAKE CYLINDER.

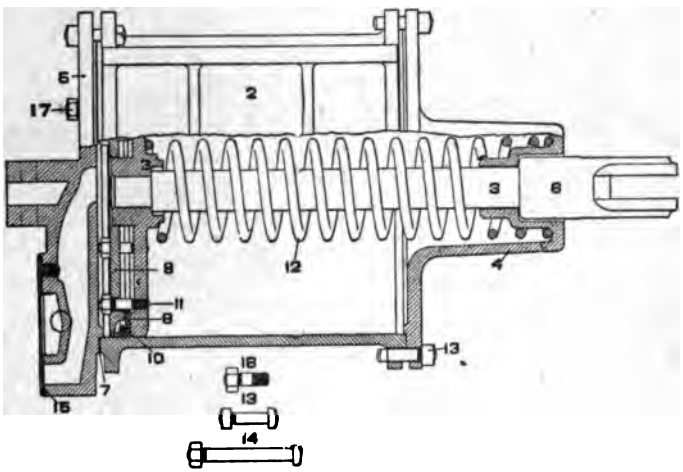


No. 1. Twelve-inch Passenger-Car Brake Cylinder, complete.

No.	
2.	Cylinder Body.
3.	Piston and Rod (includes Follower Studs and Nuts).
4.	Non-Pressure Head.
5.	Pressure Head (includes No. 16, and 2 of No. 14).
6.	Cross Head.
7.	Cylinder Gasket.
8.	Follower.
9.	Packing Leather.
10	Packing Expander.
11.	Follower Stud and Nut.
12.	Release Spring.
13.	Cylinder-Head Bolt and Nut.
14.	Triple-Valve Bolt and Nut.
15.	Triple-Valve Gasket.
16.	Triple-Valve Stud and Nut.
17.	Half-inch Plug.

PLATE F 31.

FOURTEEN-INCH PASSENGER-CAR BRAKE CYLINDER.

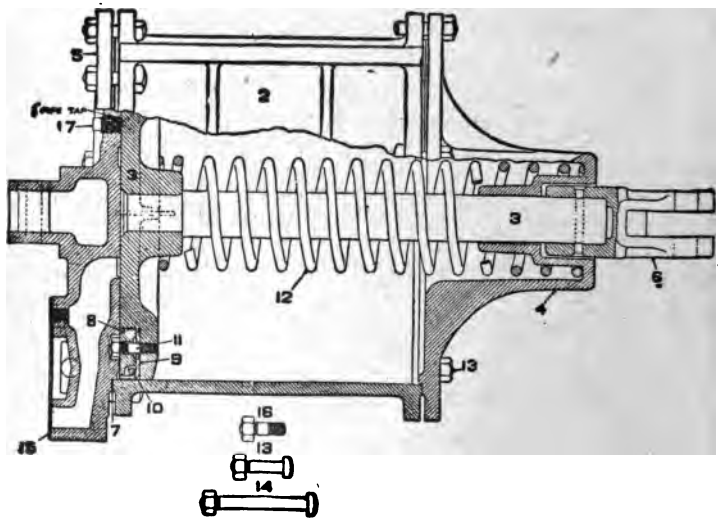


No. 1. Fourteen-inch Passenger-Car Brake Cylinder, complete.

No.	
2.	Cylinder Body.
3.	Piston and Rod (includes Follower Studs and Nuts)
4.	Non-Pressure Head.
5.	Pressure Head (includes No. 16, and 2 of No. 14).
6.	Cross Head.
7.	Cylinder Gasket.
8.	Follower.
9.	Packing Leather.
10.	Packing Expander.
11.	Follower Stud and Nut.
12.	Release Spring.
13.	Cylinder-Head Bolt and Nut.
14.	Triple-Valve Bolt and Nut.
15.	Triple-Valve Gasket.
16.	Triple-Valve Stud and Nut.
17.	Half-inch Plug.

PLATE H 32.

SIXTEEN-INCH PASSENGER-CAR BRAKE CYLINDER.

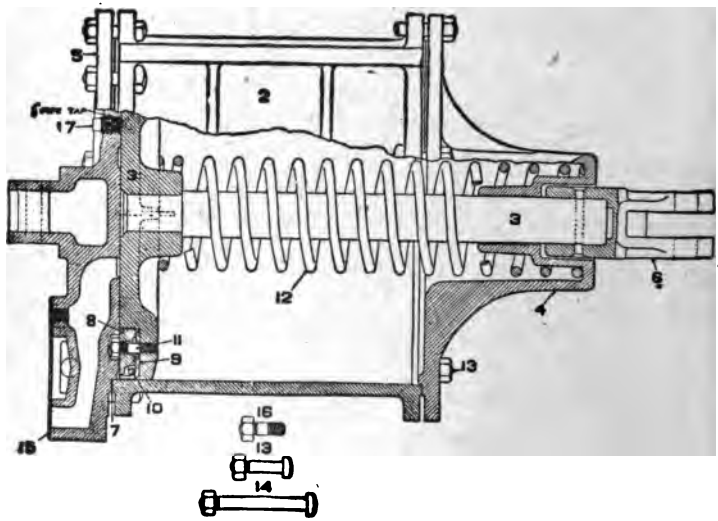


No. 1971. Sixteen-inch Passenger-Car Brake Cylinder, complete.

Ref. No.	
2.	Cylinder Body.
3.	Piston and Rod (includes Follower Studs and Nuts only)
4.	Non-Pressure Head.
5.	*Pressure Head (includes No. 16, and 2 of No. 14).
6.	Cross-Head.
7.	Cylinder Gasket.
8.	Follower.
9.	Packing Leather.
10.	Packing Expander.
11.	Follower Stud and Nut.
12.	Release Spring.
13.	Cylinder-Head Bolt and Nut.
14.	Triple-Valve Bolt and Nut.
15.	Triple-Valve Gasket.
16.	Triple-Valve Stud and Nut.
17.	Half-inch Plug.

PLATE H 32.

SIXTEEN-INCH PASSENGER-CAR BRAKE CYLINDER.



No. 1971. Sixteen-inch Passenger-Car Brake Cylinder, complete.

Ref. No.	
2.	Cylinder Body.
3.	Piston and Rod (includes Follower Studs and Nuts only)
4.	Non-Pressure Head.
5.	*Pressure Head (includes No. 16, and 2 of No. 14).
6.	Cross-Head.
7.	Cylinder Gasket.
8.	Follower.
9.	Packing Leather.
10.	Packing Expander.
11.	Follower Stud and Nut.
12.	Release Spring.
13.	Cylinder-Head Bolt and Nut.
14.	Triple-Valve Bolt and Nut.
15.	Triple-Valve Gasket.
16.	Triple-Valve Stud and Nut.
17.	Half-inch Plug.

PLATE G 32. DETAIL PARTS OF PASSENGER-CAR BRAKE APPARATUS.

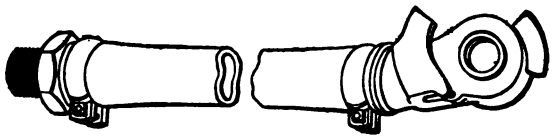


Fig. 1.

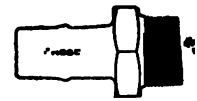


Fig. 3.

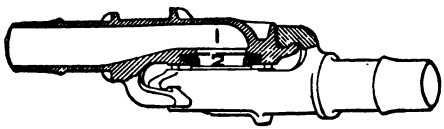


Fig. 2.

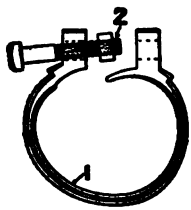


Fig. 4.

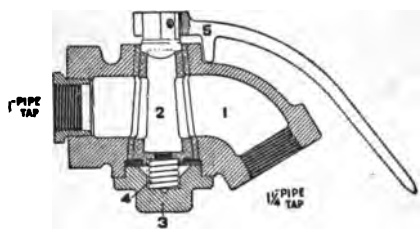


Fig. 5.

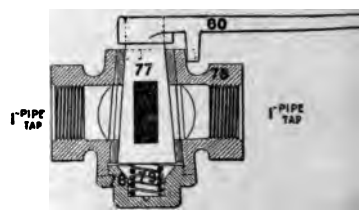


Fig. 6.

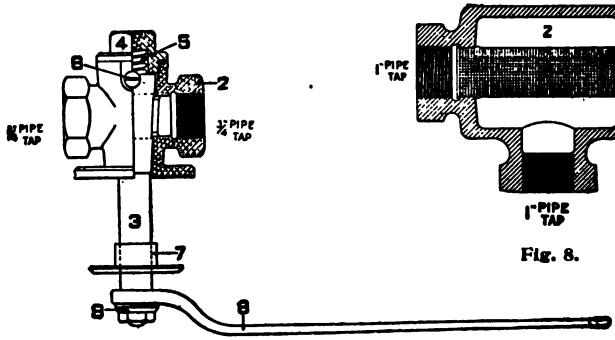


Fig. 7.

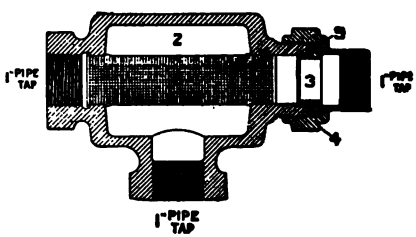


Fig. 8.

PLATE G32.

DETAIL PARTS OF PASSENGER-CAR BRAKE APPARATUS.

FIG. 1.

lard One-inch Hose and Coupling, complete.

lose 22 inches long (order in pairs.)

FIG. 2.

lard One-inch Hose Coupling (order in pairs).

lose-Coupling Case.
lose-Coupling Packing Ring.

FIG. 3.

nch by One and One-fourth inch Hose Nipple.

FIG. 4.

nch Hose Clamp, complete.

ne-inch Hose Clamp.
ne-inch Hose-Clamp Bolt.

FIG. 5.

nch by One and One-fourth inch Angle Cock, complete.

ngle-Cock Body.
ngle-Cock Key.
ngle-Cock Cap.
ngle-Cock-Key Spring.
ngle-Cock Handle.
ne and One-fourth inch to One-inch Reducer.

FIG. 6.

One-inch Cut-out Cock, complete.

No.	
76.	Cock Body.
77.	Cock Key.
78.	Cock Cap.
79.	Key Spring.
80.	Handle.

FIG. 7.

Conductor's Valve, complete.

No.	
2.	Valve Body.
3.	Valve Key.
4.	Valve Cap.
5.	Key Spring.
6.	Key Stop.
7.	Key Escutcheon.
8.	Valve Handle.
9.	Key Nut.

FIG. 8.

One-inch Brake-Pipe Air Strainer, complete.

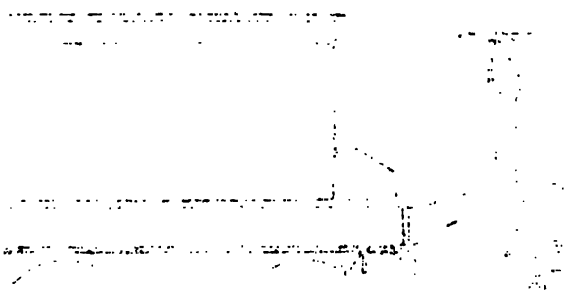
No.	
2.	Strainer Body.
3.	One-inch Union Swivel.
4.	Union Nut.
5.	Union Gasket.
6.	Strainer.

FIG. 9.

One-inch Dummy Coupling.

PLATE F 33.

Westinghouse Standard Train Air-Signal E
ment.—*Opposite.*



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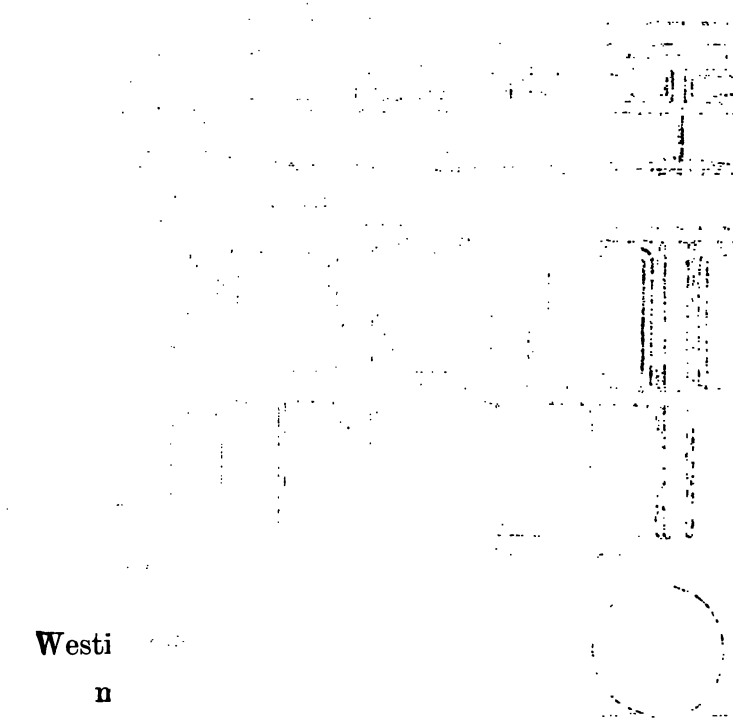


Westi

n

PLATE F 33.

STANDARD TRAIN AIR-SIGNAL APPARATUS.

FIG. 1.

Car Discharge Valve, complete.

Discharge-Valve Body.
Discharge-Valve Stem.
Discharge-Valve Spring.
Discharge-Valve Handle.
Stop Pin.
Cap Nut.
Union Nut.
Union Swivel.
Union Gasket.

FIG. 2.

Signal Valve, complete.

FIG. 3.

Improved Reducing Valve, complete.

Reducing-Valve Body (bushed).
Spring Box.
Supply Valve.
Supply-Valve Cap Nut.
Supply-Valve Spring.
Reducing-Valve Piston (includes No. 8).
8. Piston Packing Ring.
9. Piston Nut.
10. Piston Rod.
11. Diaphragm (two pieces).
12. Diaphragm Ring.
13. Regulating Spring.
14. Regulating Nut.
15. Check Nut.
16. Cock Cap Nut.
17. Cock Spring.
18. Union Nut.
19. Union Swivel.
20. Union Gasket.

*The improved Reducing Valve is adjusted to govern Train Signal-Pipe Pressure AT A MAXIMUM OF 40 POUNDS PER SQUARE INCH, and any necessary readjustment must be made for that pressure in order to secure the best results.

FIG. 4.

Signal Whistle, complete.

PLATE G 34. DETAIL PARTS OF TRAIN AIR-SIGNAL APPARATUS.

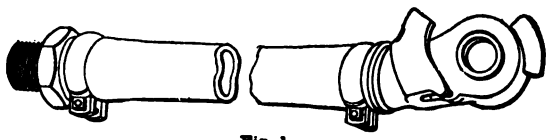


Fig. 1.

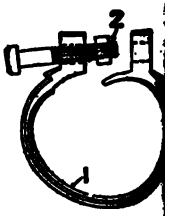


Fig. 3.

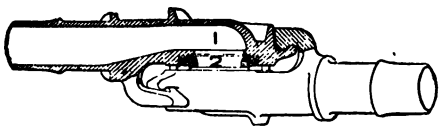


Fig. 2.

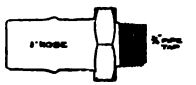


Fig. 4.

Fig. 5.

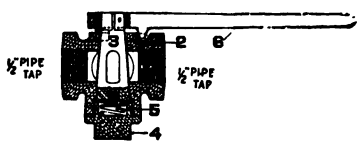


Fig. 6.

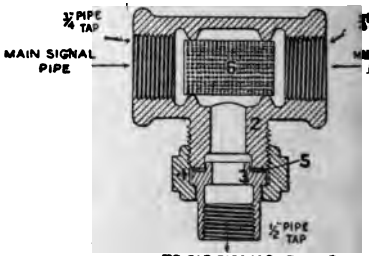


Fig. 7.

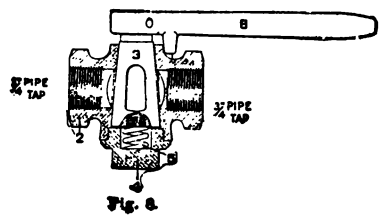


Fig. 8.

Fig. 9.

PLATE G34.

DETAIL PARTS OF TRAIN AIR-SIGNAL APPARATUS.

FIG. 1.

rd Signal Hose and Coupling, complete.

e-inch Hose, 22 inches long with fittings for ¾-inch pipe.

FIG. 2.

rd Signal Hose Coupling, complete (order in pairs).

nal Hose-Coupling Case.
nal Hose-Coupling Packing Ring.

FIG. 3.

Hose Clamp, complete.

nal Hose-Clamp Body.
nal Hose-Clamp Bolt.

FIG. 4.

ch by Three-fourths inch Hose Nipple.

FIG. 5.

fourths inch Angle Fitting.

FIG. 6.

If inch Cut-out Cock, complete.

k Body.
k Key.
k Cap.
y Spring.
k Handle.

FIG. 7.

Three-fourths inch Signal-Pipe Air Strainer, complete.

No.
2. Strainer Body.
3. Union Swivel.
4. Union Nut.
5. Union Gasket.
6. Strainer.

FIG. 8.

Three-fourths inch Cock, complete.

No.
2. Cock Body.
3. Cock Key.
4. Cock Cap.
5. Key Spring.
6. Cock Handle.

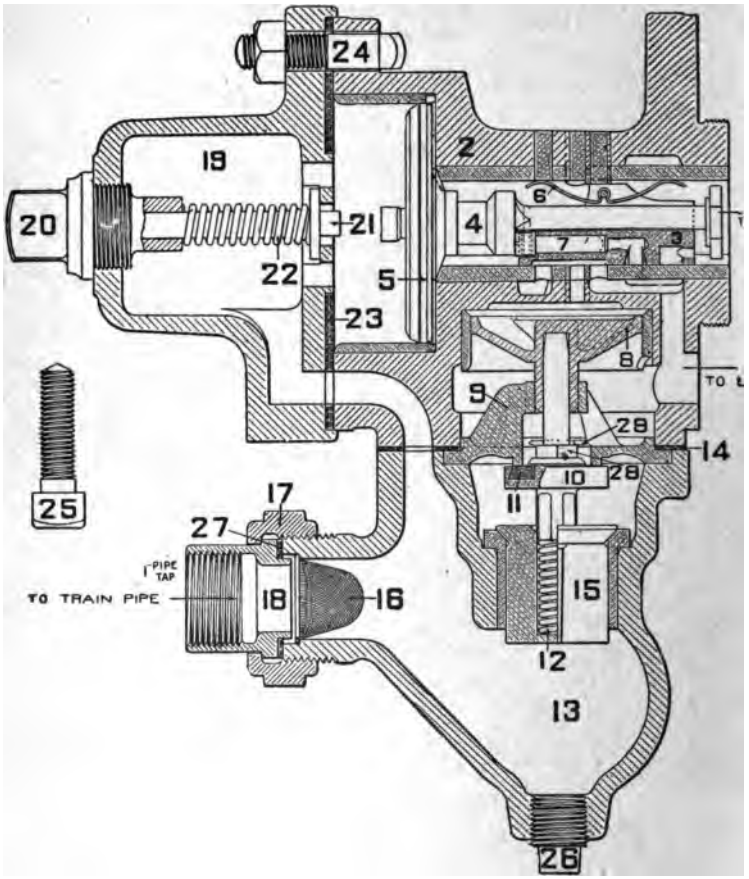
FIG. 9.

Signal Dummy Coupling.

PLATE G 35.

Westinghouse Standard Freight Car Br
Equipment.—*Opposite.*

PLATE F 36. QUICK-ACTION FREIGHT TRIPLE VALVE.



NOTE.—" F 36 " Triple Valves should be used in connection with the following apparatus only
Freight-Car Brake Cylinders, 6 inches and 8 inches in diameter.
High-Speed Tender-Brake Cylinders, 8 inches in diameter.

Though similar in appearance, this valve differs essentially from both the Passenger Tri
Valves, and should never be employed except as specified. It may be distinguished from the "F 8
and " F 29" Quick-Action Triples by the fact that it has TWO exhaust outlets (one of which is plugg
and also by the bore of its Slide-Valve Bush, which is 1 1/4 inches in diameter.

PLATE F 36.

QUICK-ACTION FREIGHT TRIPLE VALVE.

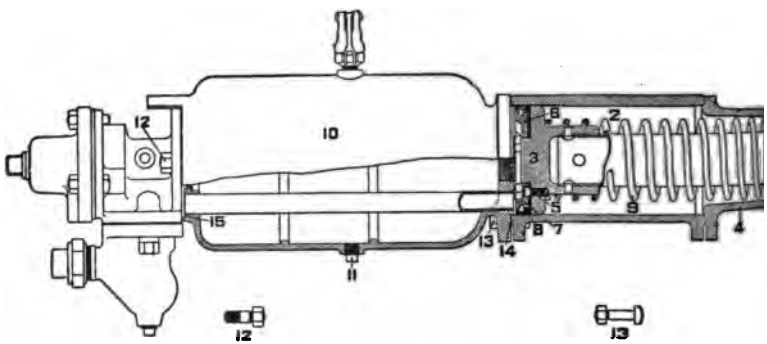
No. 1. "F 36" Quick-Action Freight Triple Valve, complete.

No.		No.	
2.	Triple-Valve Body (bushed).	17.	Union Nut.
3.	Slide Valve.	18.	Union Swivel.
4.	Piston (includes No. 5).	19.	Cylinder Cap.
5.	Packing Ring.	20.	Graduating-Stem Nut.
6.	Slide-Valve Spring.	21.	Graduating Stem.
7.	Graduating Valve.	22.	*Graduating Spring.
8.	Emergency-Valve Piston.	23.	Cylinder-Cap Gasket.
9.	Emergency-Valve Seat.	24.	Bolt and Nut.
10.	Emergency Valve.	25.	Half-inch Cap Screw.
11.	Rubber Seat.	26.	Half-inch Plug.
12.	Check-Valve Spring.	27.	Union Gasket.
13.	Check-Valve Case.	28.	Emergency-Valve Nut.
14.	Check-Valve-Case Gasket.	29.	Cotter Pin.
15.	Check Valve.	30.	Plug for Exhaust Outlet.
16.	Strainer.		

*GRADUATING SPRING SPECIFICATIONS: Forty-nine one thousandths ($\frac{49}{1000}$) inches diameter, Nickeled Steel "Piano" Wire: 16 coils; 2 3/4 inches free height; $\frac{11}{16}$ inches inside diameter.

PLATE F 37.

NARROW-GAUGE FREIGHT-CAR BRAKE CYLINDER AND AUXILIARY RESERVOIR COMBINED, WITH "F 36" TRIPLE VALVE.



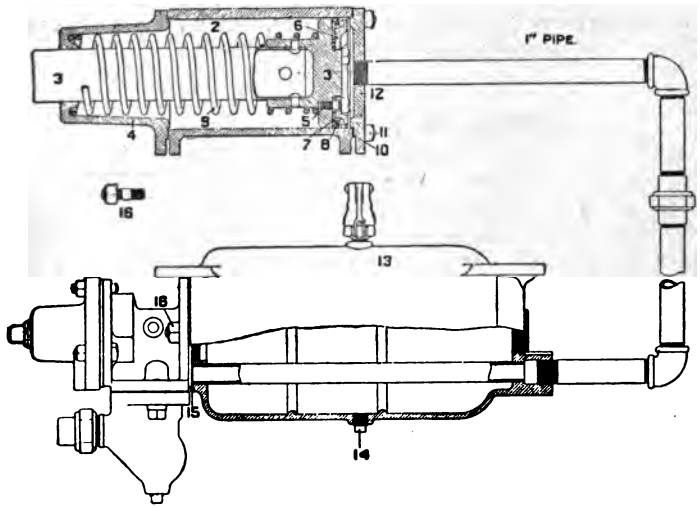
NOTE.-The "F 37" Brake Apparatus illustrated above is furnished with "Schedule H-4" f freight cars, the light weight of which does not exceed 15,000 pounds. The Brake Cylinder h inches in diameter by 8 inches stroke.

No. 1. Narrow-Gauge Freight-Car Brake Cylinder and Auxiliary Reservoir Combined, with "F 36" Triple Valve, complete.

No.	
2.	Cylinder Body.
3.	Piston and Rod (includes Follower Studs and Nuts).
4.	Non-Pressure Head.
5.	Follower Stud and Nut.
6.	Follower.
7.	Packing Leather.
8.	Packing Expander.
9.	Release Spring.
10.	Reservoir (includes Nos. 11 and 1
11.	Drain Plug.
12.	Reservoir Stud and Nut.
13.	Cylinder-Head Bolt and Nut.
14.	Cylinder Gasket.
15.	Triple-Valve Gasket.

PLATE F 38.

NARROW-GAUGE FREIGHT-CAR BRAKE CYLINDER AND AUXILIARY RESERVOIR, DETACHED, WITH "F 36" TRIPLE VALVE.



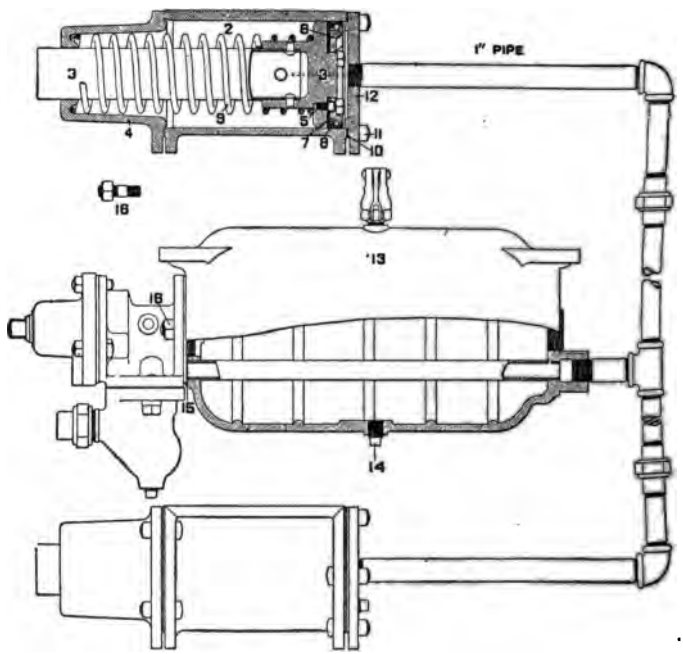
NOTE.—The "F 38" Brake Apparatus illustrated above is furnished with "Schedule H-5" for Freight Cars, the light weight of which does not exceed 15,000 pounds, but the construction of which prevents the application of the combined-cylinder-and-reservoir type of brake illustrated on Plate "F 37." The Brake Cylinder is 6 inches in diameter by 8 inches stroke.

Narrow-Gauge Freight-Car Brake Cylinder and Auxiliary Reservoir Detached, with "F 36" Triple Valve, complete.

No.		No.	
1.	Brake Cylinder, complete.	9.	Release Spring.
2.	Cylinder Body.	10.	Cylinder Gasket.
3.	Piston and Rod (includes Follower Studs and Nuts).	11.	Cylinder-Head Bolt and Nut.
4.	Back Head.	12.	Pressure Head.
5.	Follower Stud and Nut.	13.	Special Auxiliary Reservoir (includes Nos. 14 and 16).
6.	Follower.	14.	Drain Plug.
7.	Packing Leather.	15.	Triple-Valve Gasket.
8.	Packing Expander.	16.	Reservoir Stud and Nut.

PLATE F39.

"TWIN-CYLINDER" FREIGHT-CAR BRAKE APPARATUS WITH AUXILIARY RESERVOIR DETACHED, AND "F36" TRIPLE VALVE.



NOTE.—The "F 39" Brake Apparatus illustrated above is furnished with "Schedule E-6" for freight cars, the weight and construction of which prevents the use of a single-cylinder brake, either of the combined or detached type. Each of the cylinders illustrated is 6 inches in diameter by 8 inches stroke.

PLATE F39.

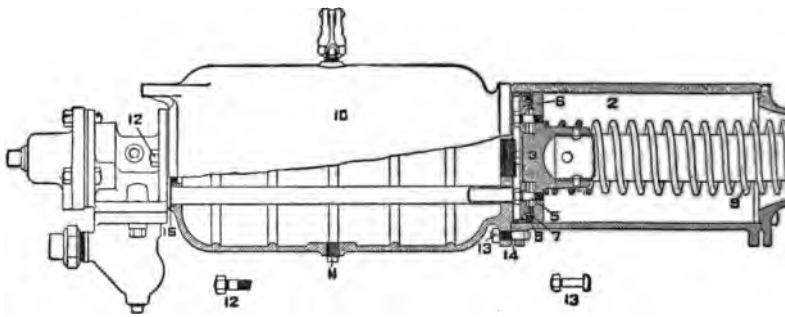
TWIN-CYLINDER" FREIGHT-CAR BRAKE APPARATUS WITH AUXILIARY RESERVOIR DETACHED, AND "F36" TRIPLE VALVE.

"Twin-Cylinder" Freight-Car Brake Apparatus with Auxiliary Reservoir Detached, and "F36" Triple Valve, complete.

No.	
1.	Brake Cylinder, complete.
2.	Cylinder Body.
3.	Piston and Rod (includes Follower Studs and Nuts).
4.	Non-Pressure Head.
5.	Follower Stud and Nut
6.	Follower.
7.	Packing Leather.
8.	Packing Expander.
9.	Release Spring.
10.	Cylinder Gasket.
11.	Cylinder-Head Bolt and Nut.
12.	Pressure Head.
13.	Special Auxiliary Reservoir (includes Nos. 14 and 16).
14.	Drain Plug.
15.	Triple-Valve Gasket.
16.	Reservoir Stud and Nut.

PLATE F 40.

STANDARD FREIGHT-CAR BRAKE CYLINDER AND AUXILIARY RESERVOIR COMBINED, WITH "F 36" TRIPLE VALVE.



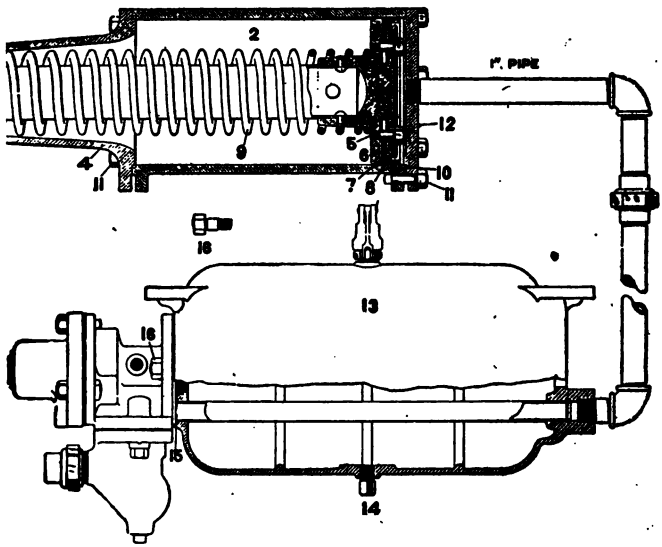
NOTE.—The "F 40" Brake Apparatus illustrated above is furnished with "Schedule H-1" f freight cars, the light weight of which exceeds 15,000 pounds. The brake cylinder is 8 inches diameter by 12 inches stroke. Together with the additional fixtures included in "Schedule H-1," constitutes the Standard Automatic-Brake Equipment for Freight-Cars.

No. 1. Standard Freight-Car Brake Cylinder and Auxiliary Reservoir Combined, wi "F 36" Triple Valve, complete.

No.		No.	
2.	Cylinder Body.	10.	Reservoir (includes Nos. 11 a 12).
3.	Piston and Rod (includes Follower Studs and Nuts).	11.	Drain Plug.
4.	Non-Pressure Head.	12.	Reservoir Stud and Nut
5.	Follower Stud and Nut.	13.	Cylinder-Head Bolt and Nut.
6.	Follower.	14.	Cylinder Gasket.
7.	Packing Leather.	15.	Triple Valve Gasket.
8.	Packing Expander.		
9.	Release Spring.		

PLATE F 41.

ARD FREIGHT-CAR BRAKE CYLINDER AND AUXILIARY RESERVOIR DETACHED, WITH "F 36" TRIPLE VALVE.



TE.—The "F 41." Brake Apparatus illustrated above is furnished with "Schedule H-2" for ars, the light weight of which exceeds 15,000 pounds, but the construction of which prevents cation of the combined-cylinder-and-reservoir type of brake illustrated on Plate "F 40." The linder is 8 inches in diameter by 12 inches stroke.

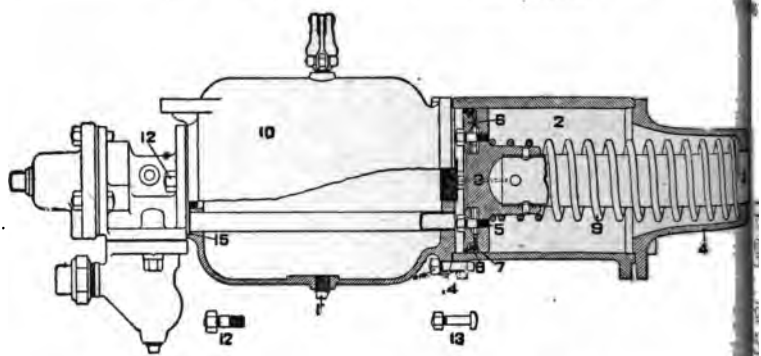
---

dard Freight-Car Brake Cylinder and Auxiliary Reservoir Detached, with "F 36" Triple Valve, complete.

	No.	
ke Cylinder, complete.	9.	Release Spring.
inder Body.	10.	Cylinder Gasket.
ton and Rod (includes Follower Studs and Nuts)	11.	Cylinder-Head Bolt and Nut.
-Pressure Head.	12.	Pressure Head.
lower Stud and Nut.	13.	Special Auxiliary Reservoir (includes Nos. 14 and 16)
lower.	14	Drain Plug.
king Leather.	15.	Triple-Valve Gasket.
king Expander	16.	Reservoir Stud and Nut.

PLATE F 42.

SHORT-STROKE FREIGHT-CAR BRAKE CYLINDER AND AUXILIARY RESERVOIR COMBINED WITH "F 36" TRIPLE VALVE.



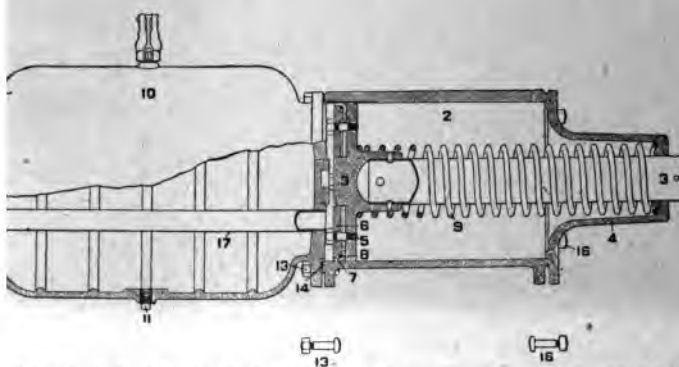
NOTE.—The "F 42" Brake Apparatus illustrated above is furnished with "Schedule H-3" for freight cars of medium weight to which a combined cylinder and reservoir of greater length cannot be successfully applied. The brake cylinder is 8 inches in diameter by 8 inches stroke.

No. 1. Short-Stroke Freight-Car Brake Cylinder and Auxiliary Reservoir Combined, with "F 36" Triple Valve, complete.

No.		No.	
2.	Cylinder Body.	9.	Release Spring.
3.	Piston and Rod (includes Follower Studs and Nuts).	10.	Reservoir (includes Nos. 11 and 12).
4.	Non-Pressure Head.	11.	Drain Plug.
5.	Follower Stud and Nut.	12.	Reservoir Stud and Nut.
6.	Follower.	13.	Cylinder-Head Bolt and Nut.
7.	Packing Leather.	14.	Cylinder Gasket.
8.	Packing Expander.	15.	Triple-Valve Gasket.

PLATE H 50.

-INCH FREIGHT-CAR BRAKE CYLINDER AND AUXILIARY RESERVOIR COMBINED, WITH "H 49" TRIPLE VALVE.



ed Ten-inch Freight-Car Brake Cylinder and Auxiliary Reservoir Combined

(includes Follower
ts only).
ead.
nd Nut.

r.
der.

Ref No	
10	Reservoir (includes Nos. 11 and 12)
11	Drain Plug.
12	Reservoir Stud and Nut.
13	Cylinder-Head Bolt and Nut (pressure end).
14	Cylinder Gasket.
15	Triple-Valve Gasket.
16	Cylinder-Head Bolt and Nut (non-pressure end).
17	Reservoir Tube.

PLATE G 43. DETAIL PARTS OF STANDARD FREIGHT-CAR BRAKE APPA

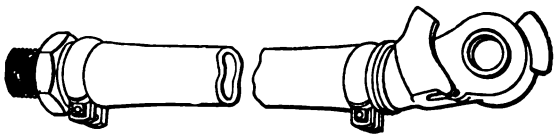


Fig. 1.

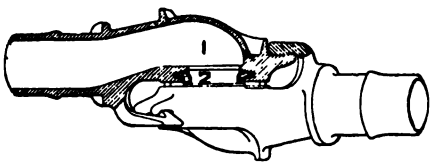


Fig. 2.

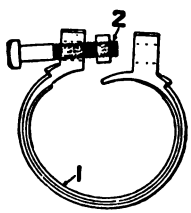


Fig. 5.

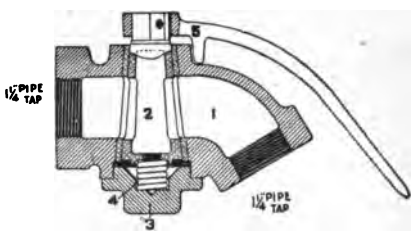


Fig. 6.

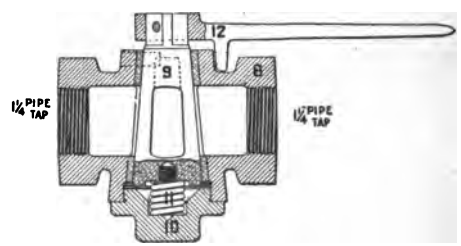


Fig. 7.

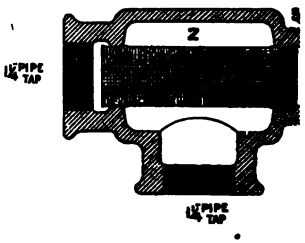


Fig. 4.

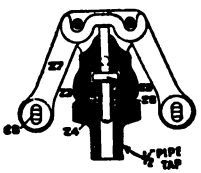


Fig. 8.

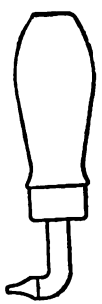


Fig. 10.

PLATE G 43.

ETAIL PARTS OF STANDARD FREIGHT-CAR BRAKE APPARATUS.

FIG. 1.

One and One-quarter inch Hose l Coupling, complete.

ches long (order in pairs.)

FIG. 2.

One and One-quarter inch se Coupling (order in pairs).

and One-quarter inch Hose upling Case.

and One-quarter inch Hose-upling Packing Ring.

FIG. 3.

)ne-quarter inch Hose Nipple.

FIG. 4.

One-quarter inch Brake-Pipe r Strainer, complete.

ner Body.

n Swivel.

n Nut.

n Gasket.

ner.

FIG. 5.

One-quarter inch Hose Clamp, nplete.

and One-quarter inch Hose amp.

and One-quarter inch Hose-amp Bolt.

FIG. 6.

One-quarter inch Angle Cock, nplete.

-Cock Body.

-Cock Key.

-Cock Cap.

-Cock Spring.

-Cock Handle.

FIG. 7.

One and One-quarter inch Cut-out Cock, complete.

No.

8. Cock Body.
9. Cock Key.
10. Cock Cap.
11. Key Spring.
12. Cock Handle.

FIG. 8.

Release Valve, complete.

No.

23. Release-Valve Cylinder.
24. Release-Valve Stud.
25. Vent Valve.
26. Release-Valve Spring.
27. Release-Valve Handle.
28. Release-Valve Pin.

FIG. 9.

Improved Pressure-Retaining Valve, complete.

No.

2. Retaining-Valve Body (includes Nos. 5, 6, 7, and 8).
3. Retaining-Valve Case.
4. Retaining-Valve Weight.
5. Retaining-Valve Handle.
6. Retaining-Valve-Cock Key.
7. Retaining-Valve-Cock Cap.
8. Retaining-Valve-Cock Spring.

FIG. 10.

Coupling-Groove Cleaning Tool.

FIG. 11.

One and One-quarter inch Dummy Coupling.

PLATE F 45.

HIGH-SPEED BRAKE AUTOMATIC REDUCING VALVE

1898 PATTERN.

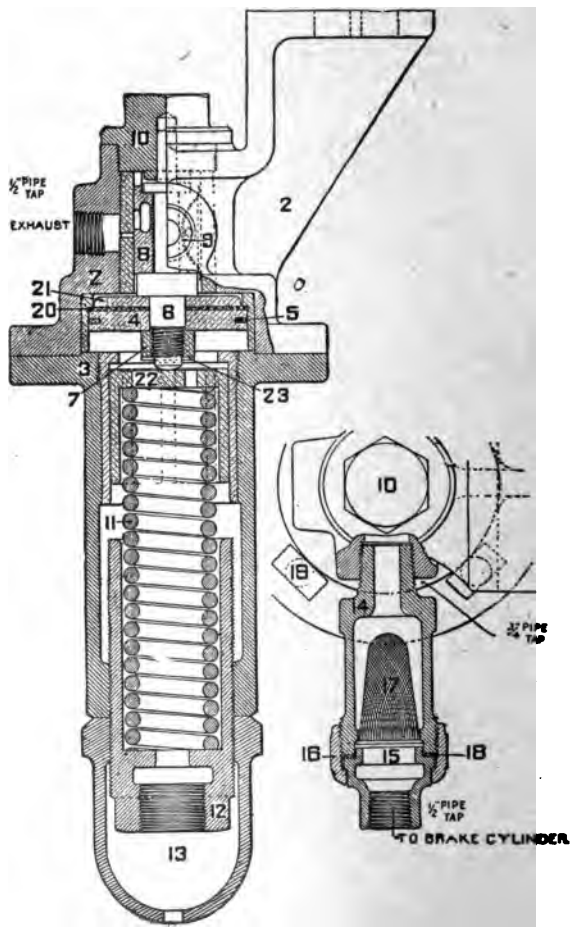


PLATE F 45.

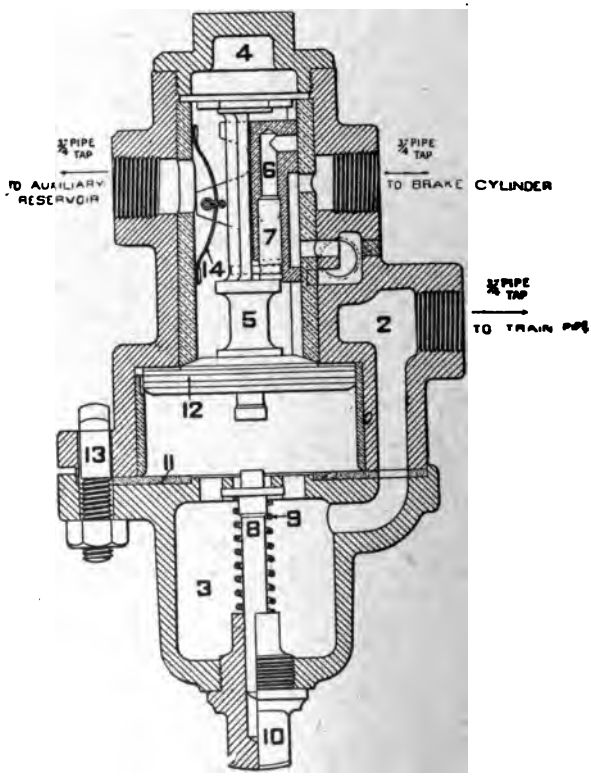
HIGH-SPEED BRAKE AUTOMATIC REDUCING VALVE.

No. 1. High-Speed Brake Automatic Reducing Valve, complete.

No.	
2.	Valve Body.
3.	Spring Box.
4.	Valve Piston (includes No. 5).
5.	Packing Ring.
6.	Piston Stem.
7.	Piston-Stem Nut
8.	Slide Valve.
9.	Slide-Valve Spring.
10.	Cap Nut.
11.	Regulating Spring.
12.	Regulating Nut.
13.	Check Nut.
14.	Union Stud.
15.	Union Swivel
16.	Union Nut.
17.	Union Strainer.
18.	Union Gasket.
19.	Bolt and Nut.
20.	Leather Washer.
21.	Piston Disc.
22.	Spring Abutment.
23.	Cotter Pin.

PLATE F 46.

HIGH-SPEED PLAIN TRIPLE VALVE.



NOTE.—This Triple Valve is designed specially for use in combination with other High-Speed Brake Appliances, for operating both Driver and Engine-Truck Brakes, and must not be used for other purposes.

PLATE F46.

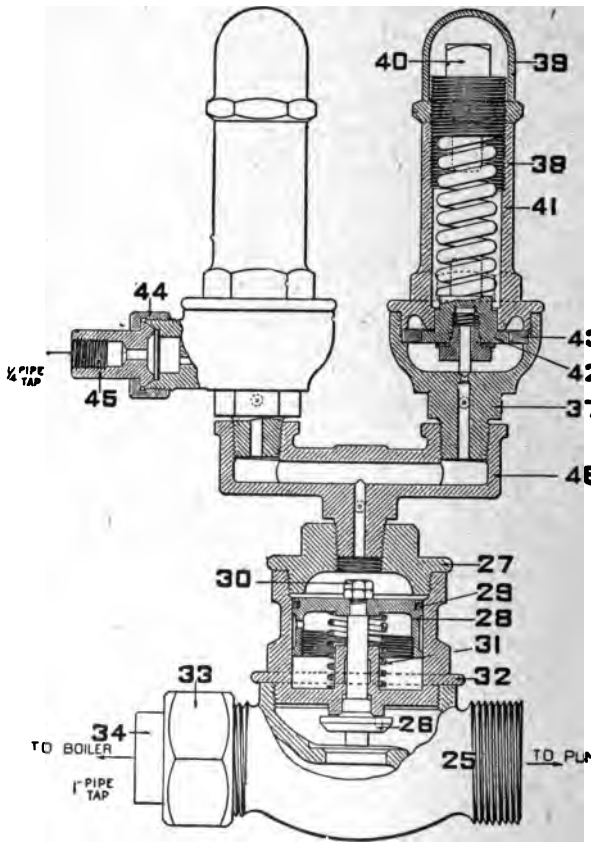
HIGH-SPEED PLAIN TRIPLE VALVE.

No. 1. High-Speed Plain Triple Valve, complete.

No.		No.	
1.	Triple-Valve Body (bushed)	9.	Graduating Spring.
2.	Cylinder Cap.	10.	Graduating-Stem Nut.
3.	Cap Nut.	11.	Cylinder Cap Gasket.
4.	Piston (includes No. 12).	12.	Packing Ring.
5.	Slide Valve.	13.	Bolt and Nut.
6.	Graduating Valve.	14.	Slide-Valve Spring.
7.	Graduating Stem.		

GRADUATING SPRING SPECIFICATIONS: Phospor-Bronze Spring Wire, No. 14 B. W. G. inches in diameter, 12 coils, 2 1/2 inches free height; ⅜ inches inside diameter.

PLATE F 47. DUPLEX PUMP GOVERNOR.



The diaphragm portion of this Governor at the right is adjusted to govern the 110-lb. pressure and the one at the left the 90-lb. pressure for ordinary braking. A 1/4-inch Cut-out Cock must be in the pipe attached to fitting 45 (see Plate "G 50") of the low-pressure diaphragm, and must be closed when operating the High-Speed Brake.

PLATE F 47.

DUPLEX PUMP GOVERNOR.

No. 1. Duplex Pump Governor, complete

No.	
25.	Steam-Valve Body.
26.	Steam Valve.
27.	Cylinder Cap.
28.	Governor Piston (includes No. 29).
29.	Piston Packing Ring.
30.	Governor-Piston Nut.
31.	Governor-Piston Spring.
32.	Steam-Valve Cylinder (includes Nos. 35 and 36).
33.	One-inch Union Nut.
34.	One-inch Union Swivel.
35.	Waste-Pipe Stud.
36.	Waste-Pipe Union Nut.
37.	Diaphragm Body.
38.	Spring Box.
39.	Cap Nut.
40.	Regulating Nut.
41.	Regulating Spring.
42.	Diaphragm, complete.
43.	Diaphragm Ring.
44.	Union Nut.
45.	Union Swivel.
46.	Siamese Fitting

PLATE F48.

DETAIL PARTS OF HIGH-SPEED BRAKE AND HIGH-PRESSURE CONTROL APPA

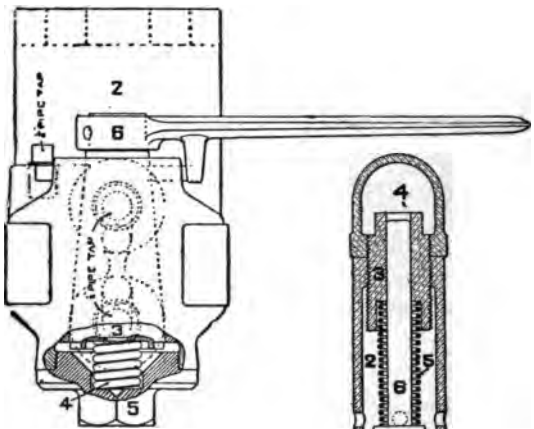


FIG. 1

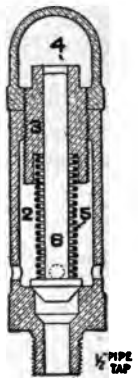


Fig. 2.

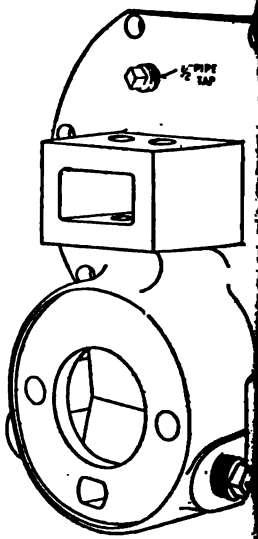


Fig. 4

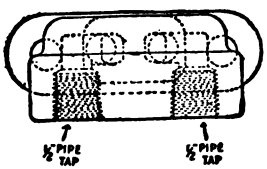


Fig. 3.

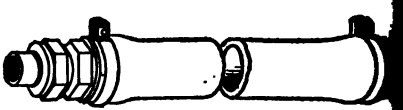


Fig. 6.

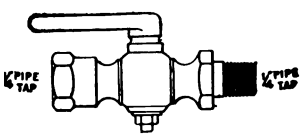


FIG. 5

PLATE F 48.

DETAIL PARTS OF HIGH-SPEED BRAKE AND HIGH PRESSURE CONTROL APPARATUS.

FIG. 1.

Feed-Valve Bracket with Reversing Cock, complete.

1. Reversing-Cock Body.
2. Reversing-Cock Key.
3. Reversing-Cock Spring.
4. Reversing-Cock Cap.
5. Reversing-Cock Handle.

FIG. 2.

Safety Valve, complete.

1. Safety-Valve Body.
2. Regulating Nut.
3. Cap Nut.
4. Regulating Spring
5. Valve.

FIG. 3.

Feed-Valve Pipe Bracket.

FIG. 4.

Tender-Cylinder Head for Quick-Action Triple Valve with Slack Adjuster Lug.

FIG. 5.

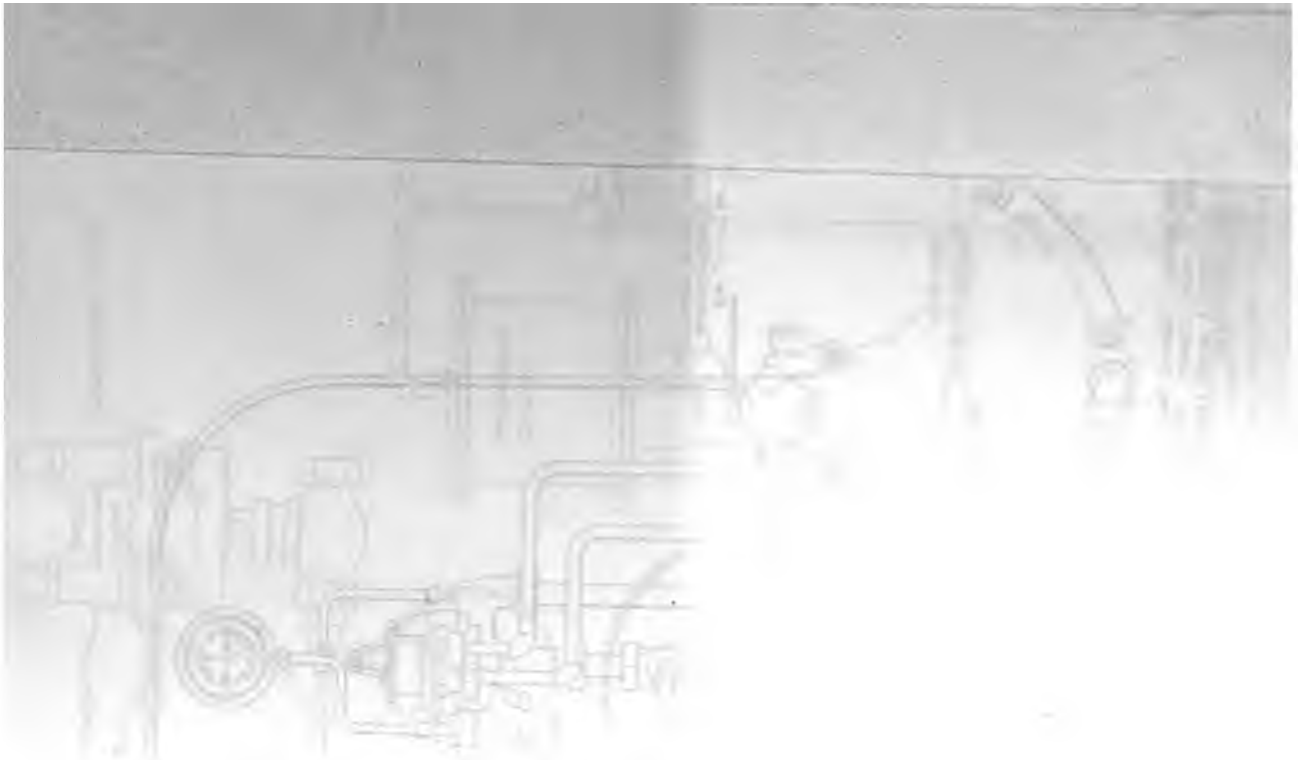
One-fourth inch Cock.

FIG. 6.

Flexible Hose Connection with Fittings for Half-inch Pipe.

PLATE G 49.

Diagrammatic Illustration of Westinghouse Pressure Control Apparatus.—*Opposite.*



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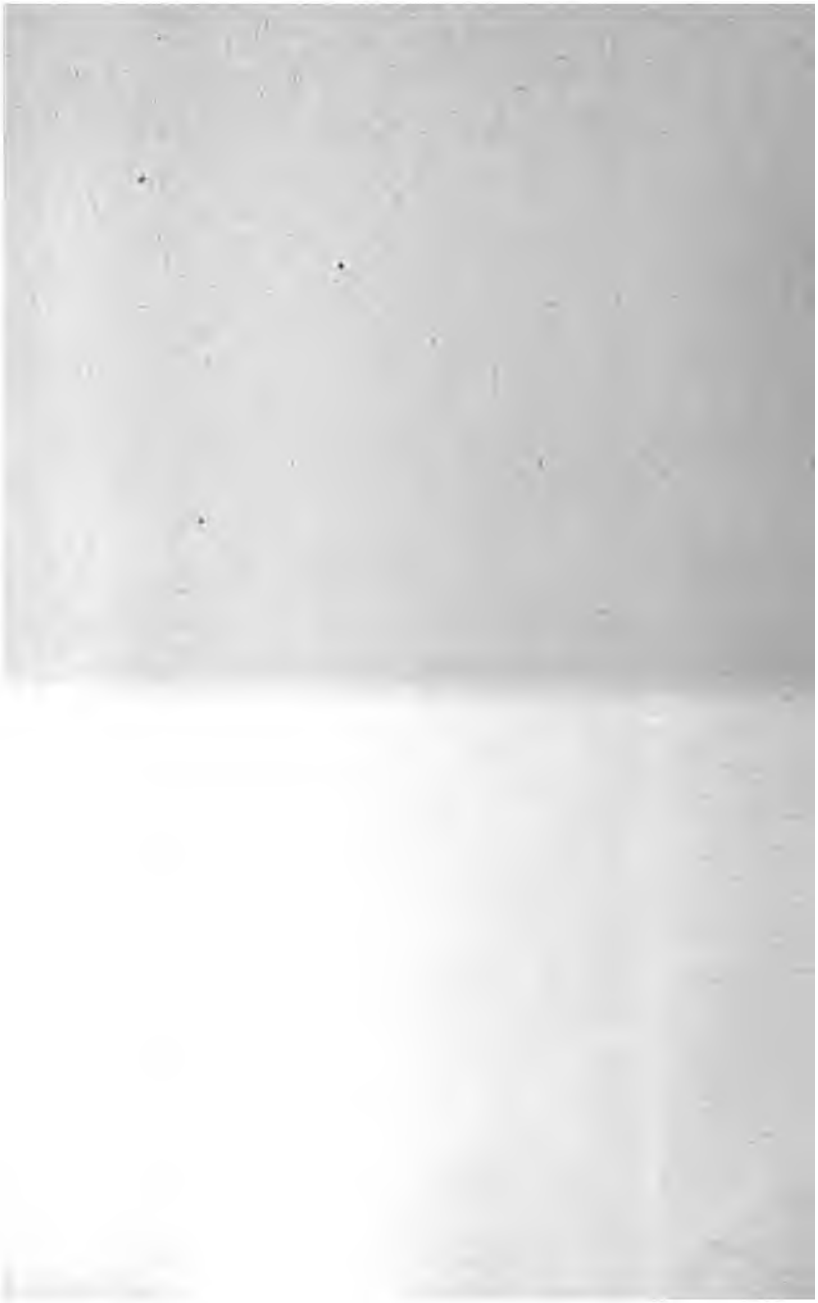

PLATE G 50.

Diagramatic Illustration of the Westinghouse Standard High Speed Brake.—*Opposite.*

I

The following are the details of the

NEW YORK AIR BRAKE

Illustrated in the following pages:

General Plan of the New York Quick Action Automatic Air Brake, Plate A1.
No. 5 Duplex Air Pump, Plate No. 5.
No. 2 Duplex Air Pump, Plate Q1.
Piston Valves for No. 2 Air Pump, Plate Q2.
Piston Valves for No. 5 Air Pump, Plate Q2A.
Engineer's Brake Valve, Plate Q3.
Plain Triple Valve for Locomotive and Tender, Plate Q4.
"Special" Driver Brake Triple Valve, Plate Q5.
Quick Action Triple Valve, Plate Q6.
K-6 Triple Valve, Plate Q2B.
Type J Triple Valve, Plate Q2C.
Pump Governor, Plate Q7.
Duplex Governor, Plate Q8.
Details of Locomotive and Tender Apparatus, Plate Q9.
Push Down Driver Brake Cylinders, Plate Q10.
Push Up Driver Brake Cylinders, Plate Q11.
Type "B" Push Driver Brake Cylinders, Plate Q12.
Type "C" Push Driver Brake Cylinders, Plate Q13.
Pull Up Driver Brake Cylinders, Plate Q14.
Type "A" Pull Driver Brake Cylinders, Plate Q15.
Type "D" Engine Truck Brake Cylinders, Plate Q16.
Cross Heads, Plate Q17.
Reservoirs, Plate Q18.
Tender Cylinders, Plate Q19.
"Special" 8-inch Passenger Car Apparatus, Plate Q20.
10-inch Passenger Car Cylinder, Plate Q21.
12-inch Passenger Car Cylinder, Plate Q22.
14-inch Passenger Car Cylinder, Plate Q23.
"Special" Quick Action Triple Valve, Plate Q24.
Details of Passenger Car Brake Apparatus, Plate Q25.
Air Signal Apparatus, Plate A3.
Details of Signal Apparatus, Plate Q26.
Narrow Gauge Freight Car Cylinder, Reservoir and Triple Valve, Plate Q27.
"Special" Narrow Gauge ditto—Detached Style, Plate Q28.
Standard Freight Car Cylinder, Reservoir, and Triple Valve, Plate Q29.
"Standard Special" ditto—Detached Style, Plate Q30.
"Special" Freight Car Cylinder, Reservoir, and Triple Valve, Plate Q31.
"Twin Cylinder" Freight Car Brake Apparatus, Plate Q32.
Details of Freight Car Brake Apparatus, Plate Q33.
Extra Details, Plate Q34.
Driving Wheel Brakes.
Schedules of Equipment.
Tables of Pipe and Pipe Fittings.
Drawing of Locomotive and Tender Equipment, Plate A2. } At the
Drawing of Passenger Car Equipment, Plate A4. } End of
Drawing of Freight Car Equipment, Plate A5. } the App.

*Similar detailed drawings of the WESTINGHOUSE AIR BRAKE are given on the preceding pages in this Appendix.

Principle of Operation.

The "Air Brake" provides means for generating power, and making it effective t wheels of each vehicle at practically the same instant of time. It is, in fact, an automatic a for quickly and safely stopping a railway train to suit conditions of service both *usual* and *e*

The engineer, by simple movements of a small handle in the cab, operates and has t trol of the brakes under all circumstances within his knowledge, but their action is entire *matic* and *independent* of the engineer if the train breaks in two, a coupling hose bur similar accident occurs. On passenger cars, the brake can also be applied by any of th men, if necessary.

The "*automatic*" action is obtained by providing each vehicle with a supply of com air that is always ready for instant use, and by means of which the shoes are forced aga wheels, or withdrawn from them, as desired. This air supply, kept at a pressure of 70 sq. in., is stored in the reservoir upon each car, and in the train pipe connecting them, th ratus being so constructed that a *reduction of train pipe pressure* will apply brakes, *increase* (restoring what has been used) will release them. Ordinarily, this reduction of tr pressure is made through the engineer's valve, but if air is permitted to escape from t pipe by *any cause*, the brakes apply automatically. If the train breaks in two, this automati occurs upon *both* sections.

The "*quick action*" is so called to distinguish its effect from the work which th performs in ordinary service. For instance, when stopping the train at stations, or othe required in daily service, the engineer *graduates* the power upon the wheels, thus appl brakes with whatever force may be necessary, lightly or otherwise, but in an emergency, w or property is in danger, the *full* brake power is *instantly* at work throughout the tr bringing it to a stop in the shortest possible distance.

Improved Car Drain Cup and Strainer.

This improved device, illustrated on Plate Q 33, meets all requirements that have be gested as desirable. The strainer is mounted on a removable spider 36, which may be uns and the strainer thus examined, cleaned or renewed *without breaking a pipe joint*. The 35 is placed at the top where water or dirt rolling along the pipe cannot reach it. It is in that shields it from flying missiles. The drainage pocket is open to catch all dirt, and emptied by unscrewing plug 32. This device may replace the older form of drain cup same pipe threads, as the connections are the same.

For Special Drain Cup, see Plate Q 84.

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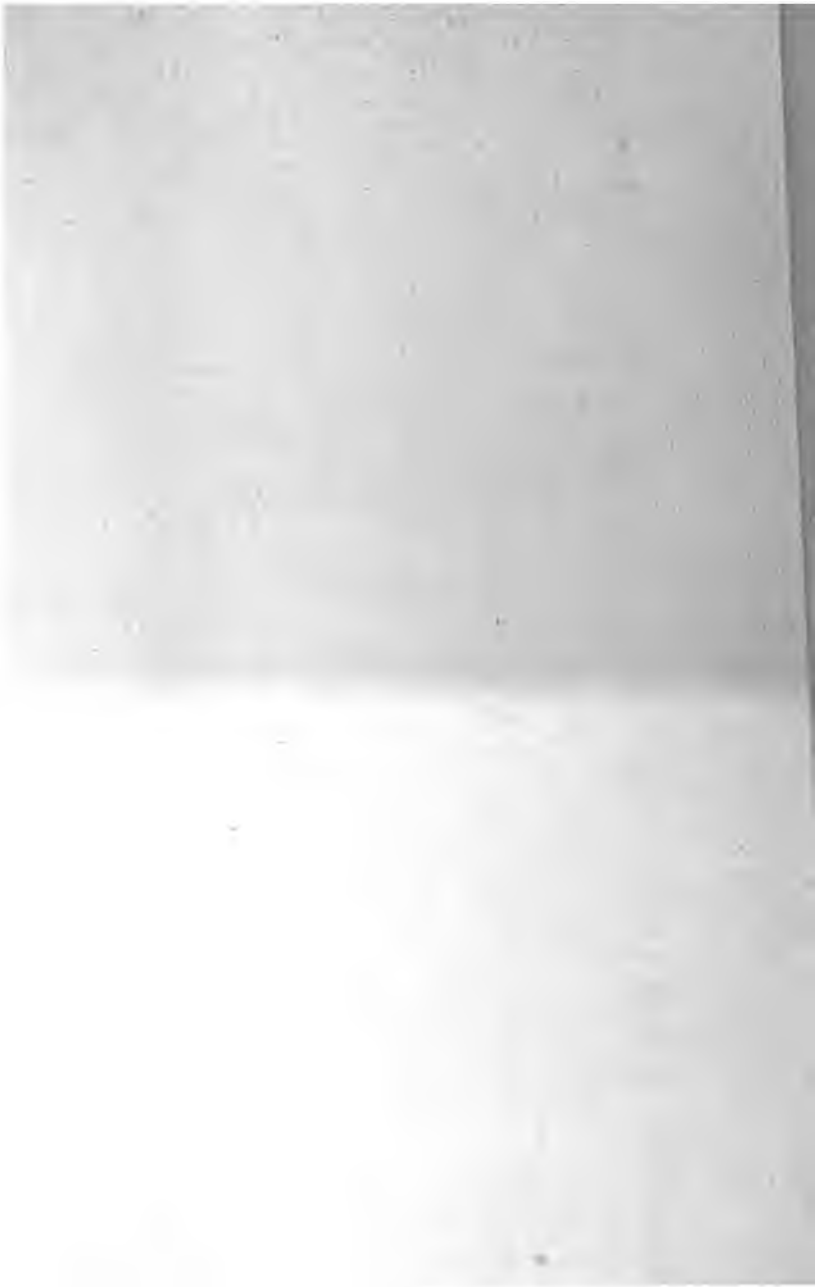


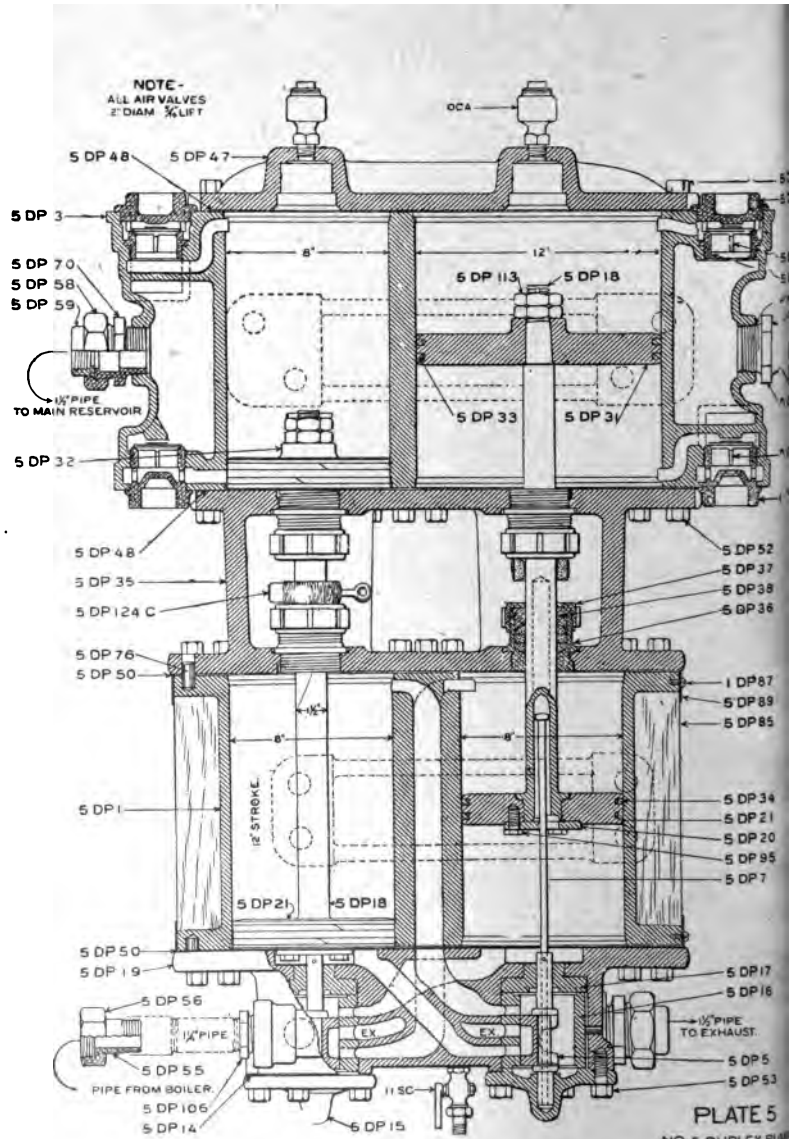


PLATE 5

NO. 5 DUPLEX PUM
PIECE NO. 5 DP

PLATE No. 5

No. 5 DUPLEX PUMP

No. 5 Duplex Pump complete (includes 2 automatic oil cups, 2 pump drain cocks, 2 swabs and 3 wrenches).
8-inch Steam Cylinders.
Air Cylinder (includes 8 of 5 DP 11, 4 each 5 DP 44, 45 and 46, 2 of 5 DP 60, and 1 each of 5 DP 58, 59 and 109).
Slide Valve, (2 pieces).
Valve Stem, (2 pieces).
1 Air Valve, 8 pieces).
4 Steam Chest Gasket, (2 pieces).
5 Steam Chest Cap, (2 pieces).
6 Steam Chest Bush, (2 pieces).
7 Valve Stem Guide, (2 pieces).
8 Piston-Rod, (to order specify 5 DP 21).
9 Steam Head, (includes 2 each 5 DP 5, 14, 15, 16, 17, 10 of 5 DP 53, and 1 of 5 DP 106).
0 Tappet Plate, (2 pieces).
1 8-inch Steam Piston and Rod, includes 1 each 5 DP 18 and 20, 2 each 5 DP 34 and 113, and 3 of 5 DP 95, 2 pieces).
1 12-inch Air Piston (includes 2 of 5 DP 33).
2 8-inch Air Piston, (includes 2 of 5 DP 34).
3 12-inch Piston Ring, (2 pieces).
4 8-inch Piston Ring, (6 pieces).
5 Center Piece (includes 4 each 5 DP 36, 37 and 38).
6 Stuffing Box, (4 pieces).
7 Stuffing Box Nut, (4 pieces).
8 Stuffing Box Gland, (4 pieces).

5 DP 44 Upper Valve Cap, (4 pieces).
5 DP 45 Upper Valve Seat, (4 pieces).
5 DP 46 Lower Valve Seat, (4 pieces).
5 DP 47 Top Head.
5 DP 48 Air Cylinder Gasket, (2 pieces).
5 DP 50 8-inch Steam Cylinder Gasket, (2 pieces).
5 DP 52 ⅝-inch x 1⅞-inch Tap Bolt, (86 pieces).
5 DP 53 ⅝-inch x 1½-inch Tap Bolt, (10 pieces).
2 DP 55 Governor Union Stud.
2 DP 56 Governor Union Nut.
5 DP 58 1½-inch Union Nut, (2 pieces).
5 DP 59 1½-inch Union Swivel (2 pieces).
5 DP 60 Air Strainer, (2 pieces).
5 DP 70 1½-inch Union Stud, (2 pieces).
5 DP 76 Dowel, (8 pieces).
5 DP 85 Steam Cylinder Jacket.
1 DP 87 Jacket Screw.
5 DP 89 Steam Cylinder Jacket Band, (2 pieces).
5 DP 95 Tappet Plate Bolt, (6 pieces).
5 DP 102 Bolt Wrench.
5 DP 103 Upper Valve Seat Wrench.
5 DP 104 Packing Nut and Lower Valve Seat Wrench.
5 DP 106 1½-inch to 1¼-inch Reducer.
5 DP 113 Piston Rod Nut, (4 pieces).
5 DP 124C Piston Rod Swab complete, (2 pieces)
5 DP 125 Piston Rod Packing.
11 SC ¼-inch Pump Drain Cock, (2 pieces).
OCA Automatic Oil Cup, Style "A" (2 pieces)

No. 2

Duplex Air Pump.

Plate Q 1 shows the No. 2 size, which is adapted for passenger locomotives haulin trains, and for freight service. It works with a smoothness and ease of opera strong contrast to the ordinary single cylinder air pumps, the absence of jarring b being particularly noticeable, and will supply air more rapidly. The valve gear is very and every part of it can be examined by unscrewing a plug. The advantages in con and durability are, therefore, evident.

In this pump, the steam cylinders form the lower half, with the air chambe them. Condensation from the steam cylinders therefore drains away naturally, compressed air delivered is as clean and dry as possible.

The action of the duplex pump in compressing air is similar to the use of s compound engine, the air being compounded instead of steam, and results in a c rr economy. Each steam cylinder is of 7 inch diameter. The high pressure air cylinder 7 inch diameter, but the low pressure air cylinder is 10 inches, and its capacity is, twice that of the steam cylinder actuating it. Each air cylinder fills with free air *at ea* as described below.

The first operation forces air from the larger air cylinder to enter the smal addition to the free air already in it, thus compelling the smaller cylinder to contain i its volume of free air, compressed to about 40 pounds. The high pressure pistons the the compression and force this air into the reservoir. In this way, the two 7 inch st are caused to actuate the equivalent of three 7 inch air pistons (the area of a 10 being double that of the 7 inch size). In other words, *two measures of steam* a *compress three similar measures of air.*

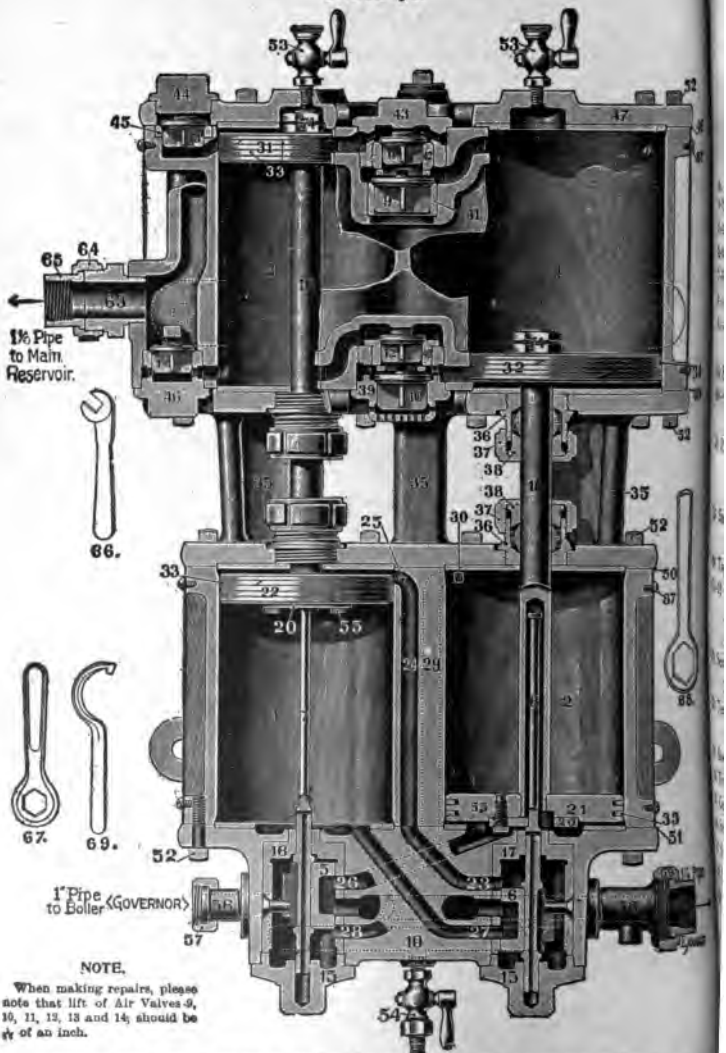
e gear is very simple. For the steam cylinders it consists of two plain D slide moving in steam chests, 16 and 17, and operated by small tappet rods, 7 and 8, nto the hollow piston rods of the steam cylinders. As is shown, the valve on one ie supply of steam to the opposite side. The air valves are simple check valves, *ravity while the pistons wait*, and, therefore, are not liable to pound themselves to pistons of one side rest while the pistons of the other side are in motion.) The follows :—

osition shown, the air piston in cylinder 4 has completed its downward stroke d its contents through valve 12 into cylinder 3. The plate 20, on steam piston valve 6 to its lowest position. *This admits steam through port* 23, 24, 25, *to upper* 22, and will cause that piston to descend and expel the partially compressed air through valve 14 and passage shown, into the reservoir. Meanwhile, the cylinder filled *above* the piston with air at atmospheric pressure through valve 9, and will be filled with air at atmospheric pressure through valves 9 and 11, both inward, and are seated by gravity. When piston 22 reaches the end of its down- he plate 20 strikes the tappet on valve stem 7 and moves valve 5 to its lowest ncovering port 26 and *admitting steam to the lower side of piston* 21, causing piston compress the air which is in cylinder 4, through valve 11 into upper part of st as piston 21 completes its stroke, its plate 20 strikes the tappet on valve stem lve 6 to its highest position, uncovering port 27 and *admitting steam to the lower* 22, causing that piston to rise and expel the partially compressed air in cylinder lve 13 into passage shown, and thence into the reservoir. While the pistons ig the air above them into the reservoir, the air cylinders below the pistons with air at atmospheric pressure through valves 10 and 12, ready for another tion.

d with the ordinary single cylinder pumps, which have the steam and air ne same size, and, therefore, compress one measure of air with one measure Duplex Pump, which compresses three measures of air with but two measures 50 per cent. greater efficiency.

No. 2 Duplex Air Pump.

PLATE Q 1.



NOTE.

When making repairs, please note that lift of Air Valves 9, 10, 11, 12, 13 and 14 should be $\frac{1}{16}$ of an inch.

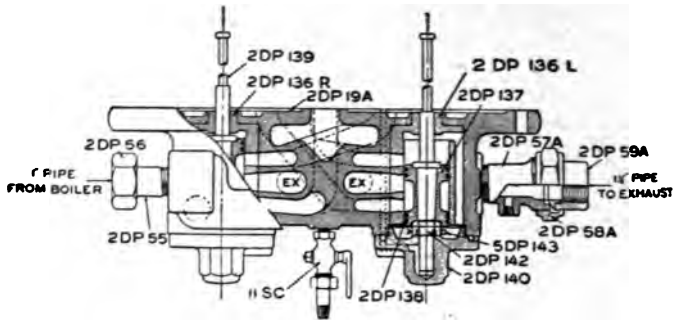
Steam and Exhaust openings are now provided on both sides of the pump, so that it can be placed on either the right or left side of the locomotive, by simply changing plugs. It is arranged for the right hand side, unless otherwise specified.

Parts of No. 2 Duplex Air Pump.

PLATE Q 1.

No.
2 Steam Cylinders.
4 Air Cylinders.
6 Slide Valves (2 pieces).
8 Valve Stems (2 pieces).
10 Receiving Air Valves (2 pieces).
11–12–13–14 Discharge Air Valves (4 pieces).
15 Steam Chest Caps (2 pieces).
16–17 Steam Chest Bushings. (Specify "right" or "left.")
18 Piston Rods (2 pieces), (includes 1 each of Nos. 20-21, and 2 each of Nos. 33–55–74).
19 Steam Head (includes Nos. 5–6, 16, 17, and 2 of No. 15).
20 Tappet Plates (2 pieces).
21–22 Seven-inch Steam Pistons (includes 1 each of Nos. 18–20, and 2 each of Nos. 33–55–74).
31 Seven-inch Air Piston (includes 2 of No. 33).
32 Ten-inch Air Piston (includes 2 of No. 34).
33 Seven-inch Piston Rings (6 pieces).
34 Ten-inch Piston Rings (2 pieces).
35 Centre Piece (includes 4 of No. 36).
36 Stuffing Boxes (4 pieces).
37 Stuffing Box Nuts (4 pieces).
38 Stuffing Box Glands (4 pieces).
39 Lower Receiving Valve Chamber.

No.
40 Lower Intermediate Valve Seat.
41 Upper Receiving Valve Seat.
42 Upper Intermediate Valve Seat.
43 Upper Intermediate Valve Chamber.
44 Upper Discharge Valve Cap.
45 Upper Discharge Valve Seat.
46 Lower Discharge Valve Seat.
47 Top Head.
48 Upper Air Cylinder Gasket.
49 Lower Air Cylinder Gasket.
50 Upper Steam Cylinder Gasket.
51 Lower Steam Cylinder Gasket.
52 Cylinder Head Bolts (62 pieces).
53 Oil Cups (2 pieces).
54 Drain Cock.
55 Tappet Plate Bolt (4 pieces).
56 Governor Union Stud.
57 Governor Union Nut.
58 Exhaust Union Stud.
59 Exhaust Union Nut.
60 Exhaust Union Swivel
63 Air Union Stud.
64 Air Union Nut.
65 Air Union Swivel.
66 Cylinder Head Bolt Wrench.
67 Cap Wrench.
68 Valve Chamber Wrench.
69 Packing Nut Wrench.
74 Piston Rod Nut.
87 Jacket Screws.



Piston Valves for No. 2 Air Pump.

PLATE Q 2.

No. 2 A DUPLEX AIR PUMP.

DETAILS.

2 DP 19A Steam Head, **includes 8 pcs. 2DP 138, 2 pcs. each 2DP 136R, 136L, 2 DP 137, 2 DP 139, 2 DP 140, 2 DP 142. 5 DP 143.**

2 DP 55 Governor Union Stud.

2 DP 56 Governor Union Nut.

2 DP 57A Exhaust Union Stud.

2 DP 58A 1¼ in. Union Nut.

2 DP 59A 1¼ in. Union Swivel.

*2 DP 136R Steam Chest Bushing.

*2 DP 136L Steam Chest Bushing.

*2 DP 137 Piston Valve, (2 per pump), **(includes 4 of 2 DP 138).**

*2 DP 138 Piston Valve Ring, (8 per pump).

*2 DP 139 Valve Stem, (2 per pump).

*2 DP 140 Steam Chest Cap, (2 per pump).

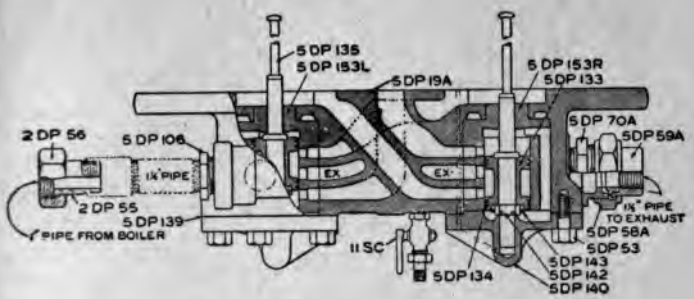
*2 DP 142 Valve Stem Nut, (2 per pump).

*5 DP 143 Valve Stem Cotter, (2 per pump).

II SC ¼ in. Pump Drain Cock, **(2 per pump).**

NOTE.—Items marked * are the **details necessary to change** the old slide valve pumps to the new **piston valve type.**

NOTE.—The Piston Valve is an **improvement over the Slide Valve,** and is used in Duplex Pumps, manufactured by **THE NEW YORK AIR** BRAKE COMPANY, in place of Slide Valves **formerly used.** The Piston Valves can be applied to Steam **Heads formerly equipped** with Slide Valves by applying new Steam **Chest Bushings and Caps,** and drilling the relief port in the Steam **Head.**



Piston Valves for No. 5 Air Pump.
Plate Q2A.

No. 5A DUPLEX AIR PUMP.

DETAILS.

5 DP 19A STEAM HEAD, includes 10 pcs., 5 DP 53, 8 pcs., 5 DP 134, 2 pcs. each, 5 DP 133, 5DP 135, 5DP 139, 5 DP 140, 5 DP 142, 5 DP 143, 1 pc. ea. 5 DP 106, 5 DP 153R, 5 DP 153L.

5 DP 53 ⅝ in. by 1½ in. Tap Bolt, (10 per Pump Head).

5 DP 55 Governor Union Stud.

2 DP 56 Governor Union Nut.

5 DP 58A 1½ in. Union Nut.

5 DP 59A 1½ in. Union Swivel.

5 DP 70A 1½ in. Union Stud.

5 DP 106 1½ in. to 1¼ in. Reducer.

*5 DP 133 Piston Valve, (2 per pump) (includes 4 of 5 DP 134).

*5 DP 134 Piston Valve Ring, (8 per pump).

*5 DP 135 Valve Stem, (2 per pump).

*5 DP 139 Steam Chest Gasket, (2 per pump).

*5 DP 140 Steam Chest Cap, (2 per pump).

*5 DP 142 Valve Stem Nut, (2 per pump).

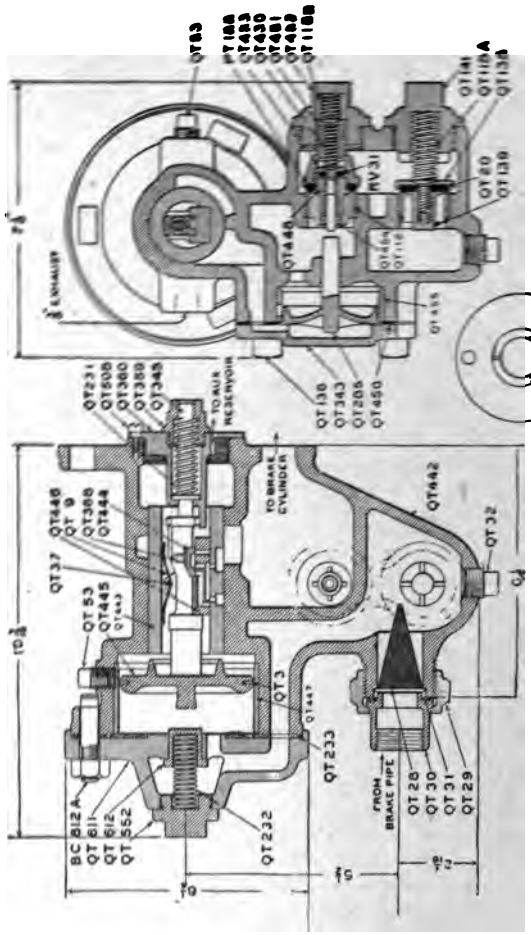
*5 DP 143 Valve Stem Cotter, (2 per pump).

*5 DP 153R Steam Chest Bushing.

*5 DP 153L Steam Chest Bushing.

11 SC ¼ in. Pump Drain Cock, (2 per pump).

NOTE.—Items marked * are the details necessary to change the old slide valve pumps to the new piston valve type.

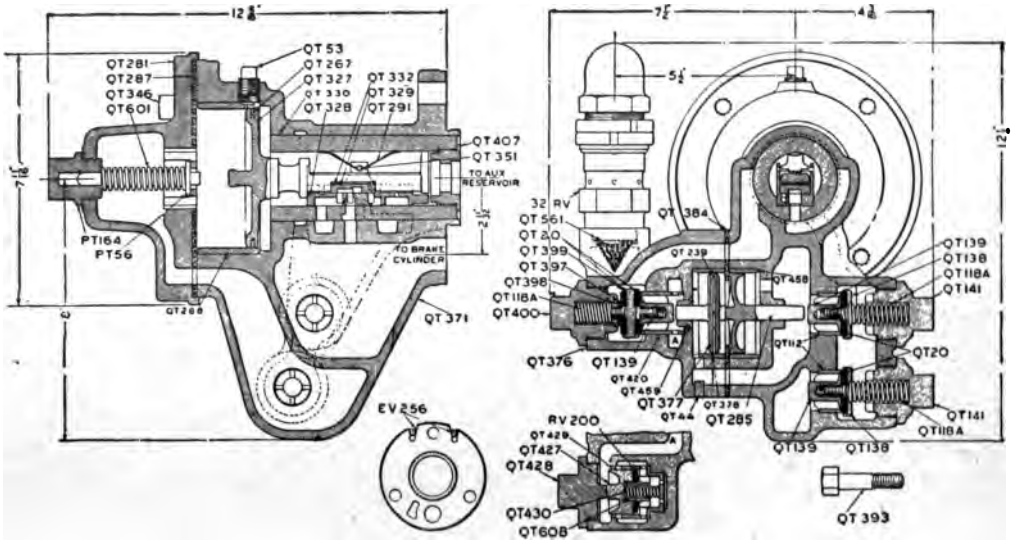


K-6 TRIPLE VALVE

NOTE. This valve, which is for use in freight service, is made two sizes. Size K-5 is to be used with 8-inch Brake Cylinders and K-6 to be used with 10-inch Brake Cylinders. The operation of t is the same.

PARTS OF K-6 TRIPLE VALVE.

3	Main Piston Ring.	QT 368	Graduating Valve Spring.
9	Slide Valve Spring.	QT 430	Quick Service Valve Spring.
20	Check Valve Seat.	QT 442	Body, Bushed.
28	Strainer.	QT 444	Graduating Valve.
29	1 in. Union Nut.	QT 445	Main Piston.
30	1 in. Union Swivel.	QT 465	Slide Valve.
31	1 in. Union Gasket.	QT 448	Emergency Valve Guide.
32	½ in. Pipe Plug.	QT 451	Emergency Valve.
37	Slide Valve Pin.	QT 452	Emergency Side Cap Nut.
53	⅜ in. Pipe Plug.	QT 453	Quick Service Valve.
8B	Emergency Valve Spring.	QT 454	Quick Service Valve Guide.
8A	B. P. Check Valve Spring.	QT 456	Side Cap Gasket.
6	Side Cap Bolts.	QT 508	Retarding Device Screws.
8	Check Valve.	QT 552	Front Cap Nut.
9	Check Valve Guide.	QT 611	Front Cap.
1	Check Valve Cap.	QT 612	Graduating Spring Guide.
1	Retard Spring.	PT 188	Emergency Valve Seat.
2	Graduating Spring.	BC 812A	Tee Head Bolts, ½ in. by 2 in.
3	Front Cap Gasket.	RV 31	Quick Service Valve Seat.
5	Emergency Piston.		
43	Side Cap.		
45	Retard Stem.		
59	Piston Stop Spring Abutment.		
360	Piston Stop Spring Box.		



SECTIONS OF J-5 STYLE A TRIPLE VALVE.
PLATE Q2C.

LISTS OF PARTS.

QT 20	Rubber Seat
PT 53	Plug
PT 56	Graduating Stem
QT 118A	Check Valve Spring
QT 138	Check Valve
QT 139	Check Valve Guide
QT 141	Check Valve Cap
QT 239	Em. Valve Piston Pkg. Ring
QT 267	Piston Packing Ring
QT 281	Front Cap
QT 285	Quick Action Piston
QT 287	Front Cap Gasket
QT 291	Exhaust Valve Spring
QT 327	Main Piston
QT 328	Exhaust Valve
QT 329	Graduating Valve
QT 332	Graduating Valve Spring
QT 346	Front Cap Bolt
QT 371	Body (bushed)
QT 376	Emergency Cap Body
QT 377	Emergency Piston
QT 384	Emergency Cap Gasket
QT 393	Tap Bolt
QT 397	Washer
QT 398	Nut
QT 399	Check Valve
QT 400	Cap Nut
QT 407	Exhaust Valve Stop
QT 427	Lower Valve
QT 428	Valve Cap
QT 430	Lower Valve Spring
QT 561	Strainer
QT 601	Graduating Spring
QT 608	Lower Valve Guide
PT 164	Graduating Stem Nut
RV 200	Lower Valve Seat
32	Safety Valve, complete

Engineer's Brake Valve.

Positive Discharge, with Feed Valve and Supplementary Reservoir.

Vaughan-McKee Patent.

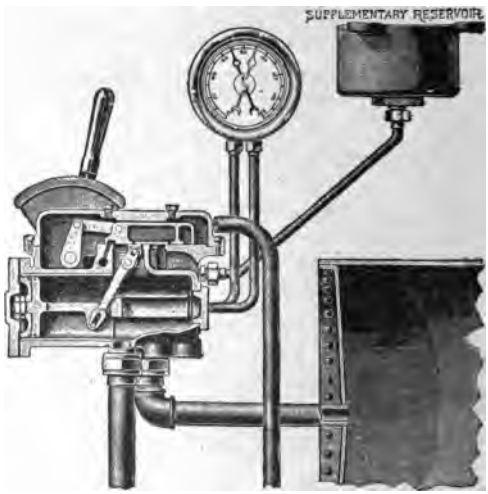


Plate Q 3 shows the construction. Figs. 1 and 2 are external views: rear end side respectively. Fig. 3 is a cross section through the feed valve (rear view). Fig. a section through the side, showing travel of slide valve 114 and how graduating valve is controlled by piston 104. Fig. 5 is a cross section through the slide valve (front vi Fig. 6 is a plan of the valve seat. Fig. 7 shows the face of the slide valve. Fig. 10 sh the supplementary reservoir.

The Principal Parts and their Duties.

Referring to Fig. 4, the chamber **B** is connected to the Main Reservoir. The chamber **A** ›onnected to the Train Pipe. Discharge of train pipe air to the atmosphere for service application, ›urs through ports **F**, **G**, and passage **C**. Main slide valve 114 controls the flow of air from the ›in reservoir to the train pipe, and from the train pipe to the atmosphere. In the drawing, the de valve occupies "Running Position." To "release," it moves to the extreme left. To "apply," moves to the right; a service application uncovering small ports **F** and **G**; an emergency applica›n uncovering the large ports **K** and **J**. (See Figs. 5 and 7.)

Small slide valve 110 is a cut-off or graduating valve, operated by piston 104. It stops the ›charge of air to the atmosphere when the train pipe pressure has fallen to the desired amount.

Piston 104 is exposed on one side to train pipe pressure in chamber **A**, and on the other side pressure from a small supplementary reservoir (connected to space **D**), and causes valve 110 to ›omatically move whatever distance is necessary to close port **F**. Decrease of train pipe pressure chamber **A** allows the pressure in the supplementary reservoir to expand, and thus move piston to the left, which, through the agency of lever 112, causes valve 110 to close port **F** by moving ›ar to the right as port **F** has been carried by slide valve 114. If the slide valve has moved only ›ort distance, piston 104 will have to move but a short distance to close port **F**, and, consequently, y a slight reduction of train pipe pressure will occur. If the slide valve carries port **F** a con›rable distance, then piston 104 must move a considerable distance to close it, and a correspond› reduction of train pipe pressure occurs. Thus, the discharge of train pipe air is greater or less, ›ording to the distance which cut-off valve 110 is required to travel.

Port **H** (Fig 6) connects with a passage running lengthwise of the valve (Figs. 1, 3, and 5), › end of which leads to the supplementary reservoir (as shown by Fig. 2), while the other end ›ds to the space **D**, back of piston 104 (Figs. 1 and 4). In "Running Position," port **J**, in the *face* slide valve 114 (Figs. 5 and 7), connects chamber **A** with port **H** in the *seat* of the slide valve ›g. 6), thus permitting train pipe air to flow into the supplementary reservoir and to the rear of ›ston, as shown. When the handle is moved to apply brakes, however, ports **J** and **H** no longer ›nect, and, therefore, the stored up air in the reservoir acts as an independent force on piston 104.

THE OPERATION: With handle in "Running Position," the valves occupy the posi›n shown in Fig. 4. Discharge ports **F** and **G** and **K** are closed, and direct communication from › main reservoir to the train pipe is cut off by the slide valve. By means of the **Feed ›lve** described below, however, the train pipe will continue to receive air, through small ›rts **E** and **M**, until the normal pressure of 70 pounds has been obtained therein.

For "Service" Application, place the handle in one of the "service" or "graduating" notches and *leave it there.* This carries slide valve 114 far enough to the right to uncover small ports F and G, thus permitting train pipe air to escape from chamber A to the atmosphere, through the exhaust passage C. Small cut-off valve 110 automatically stops the discharge as soon as the train pipe pressure in chamber A reduces enough to allow piston 104 to move, as previously explained. For light applications, use the first of the graduating notches on short trains, or the second notch with five or more cars. For heavier applications, move the handle one or two notches further. *See "Running Position" below.*

For an "Emergency" Application, quickly move the handle to position marked "emergency." This will carry slide valve 114 to the extreme right, permitting rapid discharge of train pipe air from chamber A and passage C to the atmosphere, through ports J (Figs. 5 and 7), the passage in slide valve, and the large port K (Figs. 4 and 7).

With Handle in Position of "Quick Release," slide valve 114 is moved to the extreme left, thus admitting main reservoir pressure direct from chamber B to train pipe chamber A, through the large opening which the end of the slide valve uncovers. At the same time, air contained in the supplementary reservoir is discharged to the atmosphere through passage H, port J, and passage C, thus allowing train pipe pressure to return piston 104 and cut-off valve 110 to the position shown in Fig. 4, in readiness for another service application. *When releasing brake, always place the handle in "Quick Release" position long enough to permit discharge of air from the supplementary reservoir, before moving the handle back to the "Running" position.*

With the Handle in "Running Position," the supplementary reservoir is charged to the same pressure as the train pipe. If the handle, when in "full release" position, is moved to a service notch too quickly, a full service application will result, but if it is moved slowly, or stopped in either "running" or "lap" position for a second or two, the supplementary reservoir will become charged and automatically cut off the exhaust as usual.

With the Handle in "Lap Position," all communication is cut off between the main reservoir and the train pipe; also, between train pipe and the atmosphere.

THE PUMP GOVERNOR is connected to the passage in which the well known main reservoir pressure valve or **feed valve** is located. (Figs. 3, 5, and 6.) This passage has a port g in the valve seat, which, by movements of the slide valve, is connected either with the main reservoir, with the train pipe, or is closed entirely. The governor is set at 70 lbs. With the engineer's valve handle in Full Release position, it stops the pump when both train pipe and main reservoir show 70 lbs. With handle in Running Position, the pump is not stopped until the main reservoir contains the usual excess pressure of 15 or 20 lbs. With handle in Lap Position, or one of the Application Positions, the governor does not allow the main reservoir pressure to exceed the normal amount of 85 or 90 lbs. The pump cannot, therefore, produce undue pressure whether the brakes are set, or

ased. When the handle is in running position, air from the main reservoir must pass through feed valve, port **x** (Figs. 4 and 6) and recess **m** in the slide valve (Fig. 7), in order to reach the n pipe.

The Supplementary Reservoir furnished with this valve can be placed in any venient position, but we advise attaching it to a bracket near the roof of the cab, and connecting pipe between the reservoir and the Engineer's Valve so that water cannot accumulate in the ervoir, but will drain out of it through the Engineer's Valve. Copper pipe must be used for this pose, as it can be readily bent into place, and lessens the danger of leakage by avoiding the ows and joints that are necessary with iron pipe. *All piping must be absolutely tight.*

Remarks: Do not allow the seat of the main slide valve to become dry. If the handle is too hard, remove oil plugs 96 (first letting air out of the main reservoir) and oil the seat both in at and back of the slide valve. Before putting back the oil plugs, move the handle back and forth eral times to spread the oil over the seat. It is also a good plan to occasionally remove cover 115 lubricate slide valve 114, and its seat. A good lubricant for this purpose is composed of 1 part swax, 1 part tallow, and 3 parts valve oil. Kent's Compound may also be used. The lever shaft should be oiled occasionally, through the oil hole made for that purpose in the flange of the er, back of the quadrant.

If the Valve does not cut off properly in service applications, examine back head gasket, the ing to supplementary reservoir, and the reservoir itself, for leaks.

Positive Discharge

Engineer's Brake Valve.

PLATE Q 3.

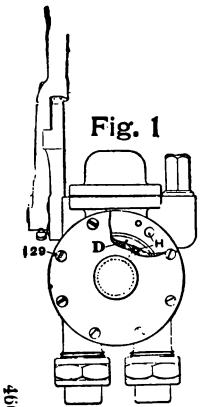


Fig. 1

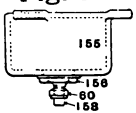


Fig. 10

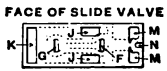


Fig. 7

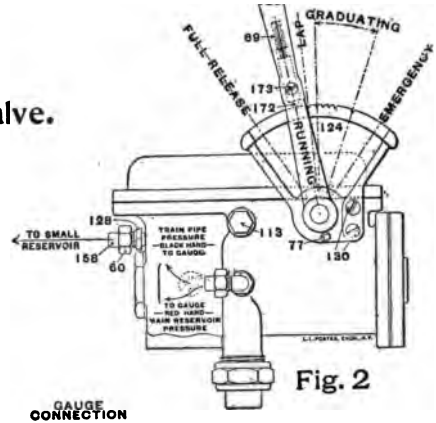


Fig. 2

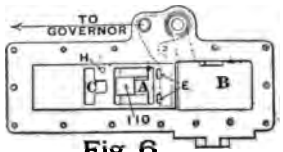


Fig. 6

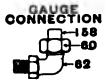
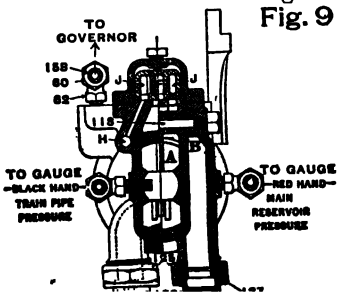
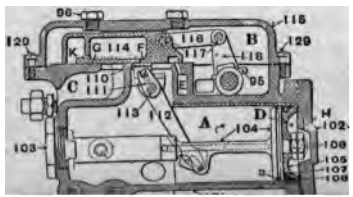
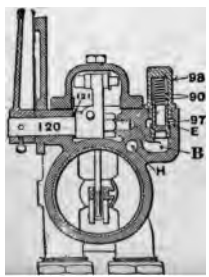


Fig. 8

Fig. 9







Parts of Engineer's Brake Valve.

PLATE Q 3.

	No.	
ing.	113	Fulcrum Pin.
nion Nut (5 pieces).	114	Main Slide Valve.
Swivel for ¼-inch Iron Pipe	115	Valve Cover.
ig. 9).	116	Links (2 pieces)
nd Governor Union Stud (3	117	Link Pins (2 pieces).
).	118	Slide Valve Lever.
Spring.	120	Lever Shaft.
Set Screw.	121	Lever Shaft Packing.
lve Spring.	123	Handle.
aft Pin.	124	Quadrant.
s (2 pieces),	125	One-inch Union Nut.
lve.	126	One-inch Union Swivel.
lve Cap.	127	One-inch Union Gasket.
ody.	128	Small Union Stud.
p.	129	Cover and Head Screws (23 pieces).
g.	130	Quadrant Screws (2 pieces).
ncludes 1 of No. 3 and 2 of	155	Supplementary Reservoir, Fig. 10, (In-
16).		cludes Nos. 156-60-158).
.	156	Reservoir Plug.
ut (2 pieces).	158	Union Swivel for ⅜-inch Copper Pipe
Leather.		(5 pieces).
r.	167	Cap Gasket.
ng Valve.	172	Quadrant Latch.
ng Valve Spring.	173	Latch Pin.
ng Valve Lever.		

This valve is provided with fittings for ⅜-inch copper pipe, for connections to entary Reservoir, the Pump Governor, and the Duplex Gauge. When ¼-inch referred for connections to the Governor and Gauge, the Union Swivel No. 61 instead of Swivel No. 158. **Always use copper pipe for connections to the ry Reservoir, however.**

Plain Triple Valve.

Plate Q 4 shows the Plain Triple Valve, *which is used only on engines and tenders* 8 *inch or* 10 *inch brake cylinders.* The parts are few, simple, and durable, and their o is not easily affected by dirt.

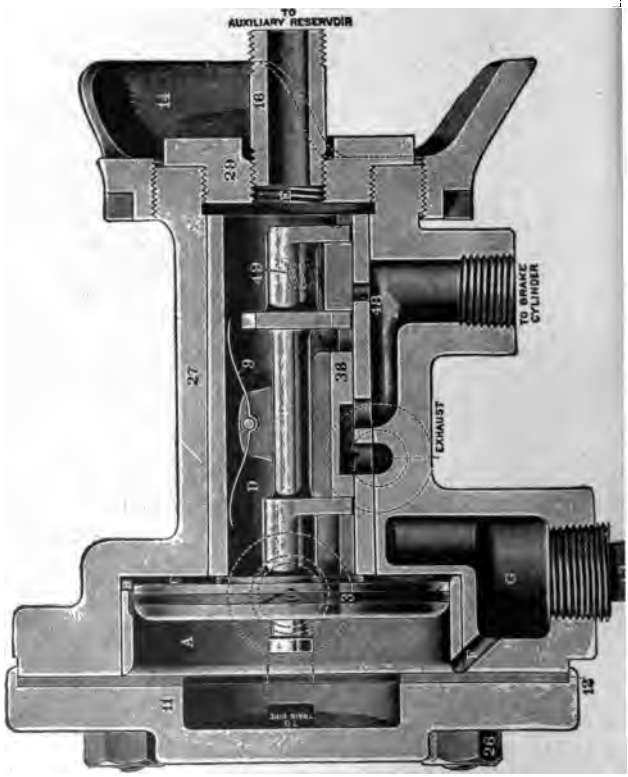
Connections are made with the auxiliary reservoir, the brake cylinder, and t pipe, as shown; slide valve 38 controls the exhaust of air from brake cylinder, to brakes, and graduating valve 48 controls the admission of air from auxiliary reservoi brake cylinder, for applying brakes. Piston 40 actuates valves 38 and 48 so that will close the exhaust port before graduating valve 48 opens the service port. The sl 38 can remain stationary while the piston 40 returns part way and causes graduati 48 to cover the service port, as the abutments that move valve 38 are farther apart length of the valve.

The operation is as follows: Air from the train pipe passes to cylinder A, charging groove B and passage C to chamber D, and thence through passage E auxiliary reservoir. *When the train pipe pressure is reduced,* the piston 40 moves its fu first cutting off the flow of air to auxiliary reservoir, by closing the charging groove causing valve 38 to cover exhaust port, and valve 48 to open the service or graduat and allow reservoir air to enter the brake cylinder, the quantity admitted being in pr to the reduction of train pipe pressure. If the train pipe pressure is reduced b the pressure in the reservoir is soon reduced to slightly less than that in the tr and the piston 40 starts back and moves graduating valve 48 *without disturbing slide* which is held with some force by the air pressure, aided by spring 9, and checks the retu when valve 48 has closed the service port. *A further reduction of train pipe pressur* the same action and applies the brakes a little harder. If the train pipe pressure is 5 to 8 pounds, the brakes will be applied with but moderate force, but if the train pipe p reduced 20 pounds, the graduating valve 48 will remain open and the brakes go fi the auxiliary reservoir pressure will then continue to flow into the brake cylinder pressure in each is equalized.

An increase of pressure in the train pipe will cause all the valves to move back to the ition shown in the Plate, thus releasing the brakes and allowing the reservoir to be harged. Passage F allows moisture from the train pipe to collect into chamber G, where an be readily drained by unscrewing plug 13.

Plain Triple Valve.

PLATE Q 4.



NOTE.—For use with { 8-inch and 10-inch Driver Brake Cylinders. 8-inch and 10 inch Tender Brake Cylinders.

Always use a one-half inch Cut out Cock (Fig. 8, Plate Q 23) in the branch pipe between this valve and the train pipe, for "Cutting Out" the valve in case of injury to the driver brake or tender brake.

Parts of Plain Triple Valve.

For 8 inch and 10 inch Cylinders Only.

PLATE Q 4.

No.	
	ı Ring.
	Valve Spring.
	ːt.
	Plug.
	et.
	le.
26	Cap Bolt (4 Pieces).
27	Triple Valve Body.
29	Plug.
38	Slide Valve.
40	Piston (includes No. 3).
48	Graduating Valve.
49	Graduating Valve Spring.

"Special"
Driver Brake Triple Valve.

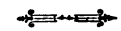


Plate Q 5 shows a Plain triple valve of another style, *which is only used upon engines equipped with brake cylinders of 12-inch and 14-inch diameter.* This valve was specially designed for use with cylinders of such large size and is not intended for any other purpose, or for any other size of cylinder.

The action is similar to the other Plain triple valve shown on Plate Q 4, but the parts are of different construction and are numbered differently. The operation is as follows:—

Slide valve 24 controls the discharge of air from brake cylinder to release brakes, and graduating valve 25 controls the admission of air from the auxiliary reservoir to the brake cylinder for applying brakes. Piston 23 moves both valves, causing valve 24 to close the exhaust port from the brake cylinder *before* the port from graduating valve 25 is opened. The abutments that move valve 24 are farther apart than the length of the valve. This is to allow slide valve 24 to remain stationary, while piston 23 returns far enough to cause graduating valve 25 to close the communicating port between the reservoir and cylinder.

When train pipe pressure is reduced, piston 23 moves downward until its projecting stem strikes the end of stem 26. (Spring 27, which is coiled around the stem 26, prevents further movement of the piston, except as explained below.) This movement of the piston causes valve 24 to close the port leading to the atmosphere, while valve 25 opens the port leading from reservoir to the brake cylinder, as above described. When the reservoir pressure, because of flowing into the empty brake cylinder, is reduced slightly below the pressure left in the train pipe, piston 23 will move upward far enough to cause valve 25 to stop the further use of reservoir

air. The piston will not return all the way back to its original position, because slide valve 24 (which is helped by spring 32) offers resistance. In this way, the brakes can be gently applied.

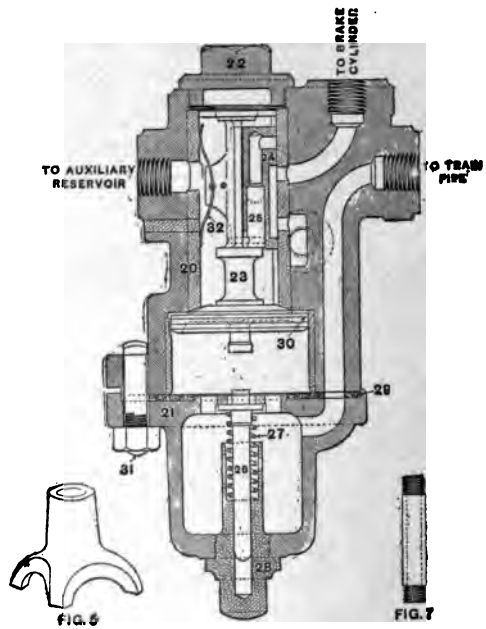
As shown in the description of the engineer's valve, a small reduction of train pipe pressure sets the brakes gently, and a large reduction of train pipe pressure sets them with full force. The small reduction causes the parts to operate as described. The large reduction causes piston 23 to move with such speed and force that it will overcome the resistance of spring 27 and move its entire stroke. This carries both valves 24 and 25 so far downward that reservoir air can flow rapidly through the passage leading to the brake cylinder, thus setting the brakes with their full force.

Increasing the train pipe pressure, will cause the piston and its valves to return to the position shown, thus allowing the auxiliary reservoir to be replenished with air, and allowing the air in the brake cylinder to escape into the atmosphere.

"Special" Driver Brake Triple Valve.

For 12 inch and 14 inch Driver Brake Cylinders.

PLATE Q 5



NOTE.—This Valve is of special design, and must only be used with 12-inch and 14-inch Driver Brake Cylinders. Always use a one-half inch Cut-out Cock (Fig 8, Plate Q 23) in the branch pipe between this valve and the train pipe, for "Cutting Out" the valve in case of injury to the driver brake parts.

Parts of
"Special" Driver Brake Triple Valve.

For 12 inch and 14 inch Driver Brake Cylinders.

PLATE O 5.

No.	
20	Valve Case.
21	Drain Cup.
22	Cap Nut.
23	Piston (includes No. 30).
24	Slide Valve.
25	Graduating Valve.
26	Graduating Stem.
27	*Graduating Spring.
28	Graduating Stem Nut.
29	Gasket.
30	Piston Ring.
31	Bolt and Nut (3 pieces).
32	Slide Valve Spring.

*No. 14 B. W. G. Phosphor Bronze Spring Wire, 12 coils, 3½ inches free height after taking permanent set.

Special Attachments for this Valve only.

Fig. 6. Bracket.
Fig. 7. Nipple.

Quick Action Triple Valve.

Plate Q 6 shows the Quick Action Triple Valve, *which is used upon cars.* The ideal sketch opposite is a more convenient illustration, however, as all working parts are on one plane. In the actual structure, some of the moving parts are at right angles to the main piston, so that all inside parts can be examined, cleaned, or renewed *without detaching the valve from the reservoir or train pipe.* This valve has the same connections and is interchangeable with those in use of another make.

The work it does is known as "service" and "emergency," the first being its ordinary action, and the second giving the very strong and *instant* application for emergency use. To accomplish the latter throughout a long train pressure from the train pipe is discharged at each car *in addition* to the reduction by the engineer. As previously explained, the ordinary service application is made by letting from 6 to 8 lbs. pressure out of train pipe, and the emergency application by a *sudden* reduction of 10 or more pounds. In either case, the reduction causes an impulse of air to travel through the train pipe and operate the triple valve on each car as it passes along. The service reduction is not powerful enough to affect the emergency parts and travels through the train with moderate speed. The emergency reduction, however, is so much more powerful that it *also* sets the emergency parts in motion, and, as they exhaust the train pipe pressure in their immediate vicinity, this impulse is transmitted from car to car with great rapidity.

The "service" parts occupy the central portion of the opposite drawing. The auxiliary reservoir is charged through the usual groove B. Exhaust valve 38 and graduating valve 48 cover the usual ports, and are moved by the main piston 128 for applying and releasing the brakes for service stops, in the manner already familiar in plain and quick action triple valves.

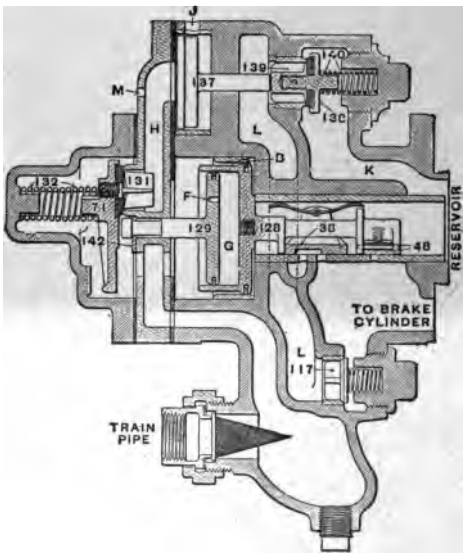
The "quick action" parts occupy the left and top portions of the drawing, and are *inoperative under ordinary conditions.* Vent valve 71 is held to its seat by spring 139, assisted by train pipe pressure, and can only be opened when piston 129 is forced to the left. Quick action valve 138–139 is held to its seat by spring 140, assisted by reservoir pressure, and can only be opened when piston 137 moves to the right. All parts are simple and durable, and the valves are so located that oil from the brake cylinder cannot possibly reach a rubber valve seat. The operation is as follows:

Main piston 128 has the same stroke for *both* service and emergency application, but is extended to form a cylinder in which piston 129 is fitted. Through piston 129 is a small opening F, allowing train pipe air to pass through and thus equalize the pressure on both sides. This opening is of such a size that when main piston 128 moves *slowly* to the left, as in *service* applications, the air in space G will be pressed through opening F *without disturbing piston* 129 from the position shown.

The sharp reduction of train pipe pressure for an *emergency* stop will cause main piston 128 to move *rapidly* to the left. In this case, air from space G cannot flow through passage F fast

enough to prevent a *momentary* pressure upon piston 129, strong enough to overcome its resistance and cause valve 71 to be pushed from its seat. This allows train pipe air to enter the passage H and escape to the atmosphere through openings J and M, while, at the same time, it forces piston 127 to the right, which unseats valve 139 and allows the *full* power of the reservoir pressure to be *instantly* effective in the brake cylinder through the large passages K and L, and check valve 117.

Meanwhile, *as passage F is always open*, the temporary pressure exerted by the air in chamber G has rapidly lost its effect, and spring 132 has returned valve 71 to its seat, *thus stopping the escape of air when train pipe pressure is sufficiently reduced to properly apply the brake*. As valve 71 closes, it returns piston 129 to its original position. (It cannot move any farther to the right than is



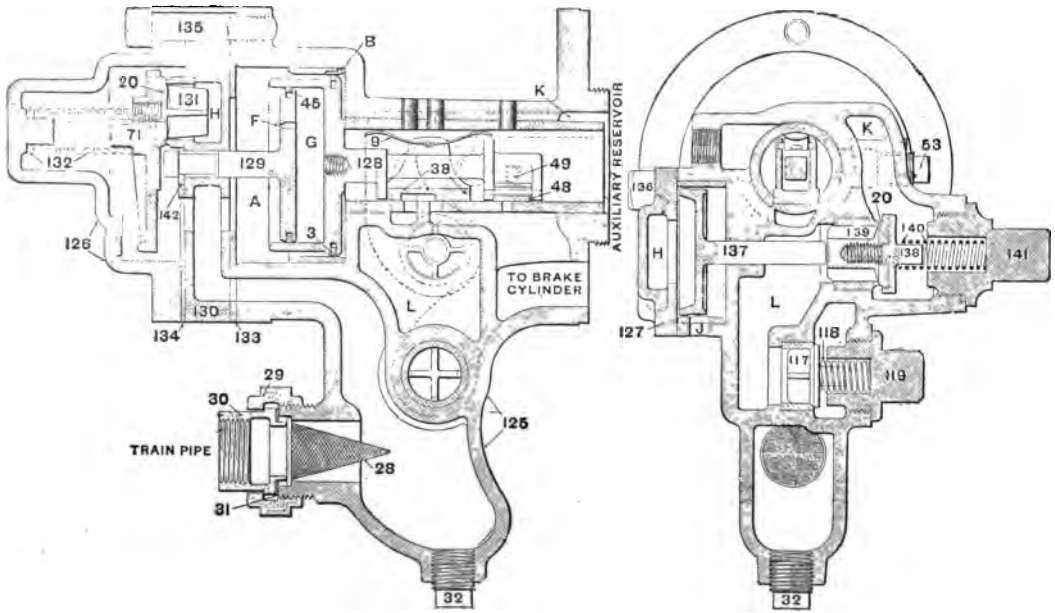
shown in the drawing, as travel in that direction is limited by the stop 142.) Valve 139 and piston 137 have also been returned to their former positions, as shown.

Releasing brakes after an emergency application is prompt and certain. *All other parts having automatically returned to their original positions while the brakes are on*, there is only main piston 128 to be moved. Restoring the train pipe pressure causes it to return valves 38 and 48 to the position shown, allowing the auxiliary reservoir to be replenished and the air to escape from brake cylinder, thus releasing the brakes.

Moisture from train pipe collects in the bottom of the valve, where it can be easily drained by unscrewing the plug provided for that purpose

Quick Action Triple Valve.

PLATE Q 6.



NOTE :—This valve is made in *two* styles. **Style "F"** for Car Cylinders of **8 Inch** and **6 Inch** diameter. **Style "P"** for Car Cylinders of **10**

Parts of Quick Action Triple Valve.

Styles "F" and "P".

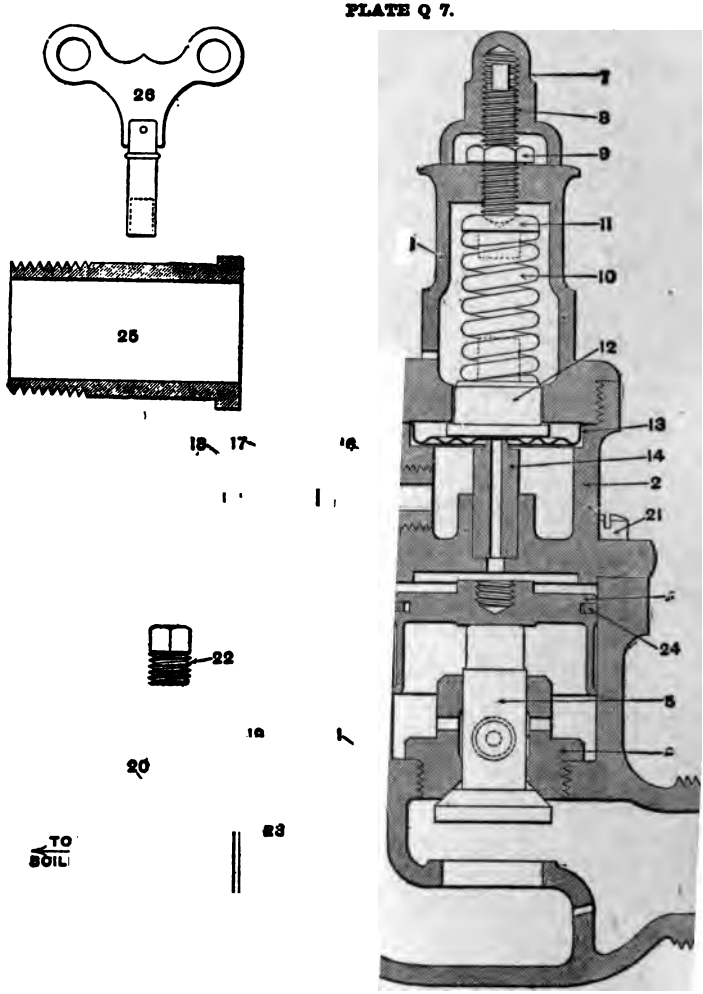
PLATE Q 6

	No	
in Piston Ring	125	Triple Valve Body
le Valve Spring	126	Front Cap
ber Valve Seat	127	Side Cap
uner	128	Main Piston (includes No. 8).
on Nut.	129	Vent Valve Piston (includes No. 15).
on Swivel	130	Vent Valve Seat.
on Gasket.	132	Vent Valve Spring.
in Plug.	133	Main Cylinder Gasket
le Valve.	134	Front Cap Gasket.
t Valve Piston Ring	135	Front Cap Bolt (3 pieces).
duating Valve.	136	Side Cap Bolt (2 pieces).
duating Valve Spring.	137	Quick Action Valve-Piston.
aust Hole Plug.	138-139-20	Quick Action Valve, complete.
-20 Vent Valve, complete.	140	Quick Action Valve Spring.
ck Valve.	141	Quick Action Valve Cap.
ck Valve Spring	142	Piston Stop.
ck Valve Cap.	143	Piston Stop Screw (not shown).

For "Special" Triple Valve, See Plate Q 24.

Pump Governor.

PLATE Q 7.



NOTE.—These Governors are furnished in Three Styles.—See "Note" on opposite p

Pump Governor.

Q 7 shows the construction. It automatically shuts off the supply of steam to the the desired air pressure is obtained in the train pipe and reservoirs, and allows start again when the air pressure falls below the limit.

valve 5 is opened by steam pressure, but closed by air pressure on top of piston n pipe pressure has reached the limit for which the governor is adjusted. When e pressure *underneath* the diaphragm 13, overcomes the tension of spring 10, the vill rise, and admit train pipe pressure to the top of piston 4, thus forcing valve and shut off the flow of steam. When the train pipe pressure falls below the limit, ill force the diaphragm to its seat, thus cutting off the supply of air to piston 4. e piston 4 will then escape through the small vent hole in the body of governor, eam pressure to open the steam valve 5 and reach the pump.

ening is provided in the chamber under piston 4, for any leakage of steam or air. ry adjustment of the regulating spring 10, may be made by means of screw 8 and

A small hole past the steam valve always admits enough steam to keep the freezing.

Parts of Pump Governor.

PLATE Q 7.

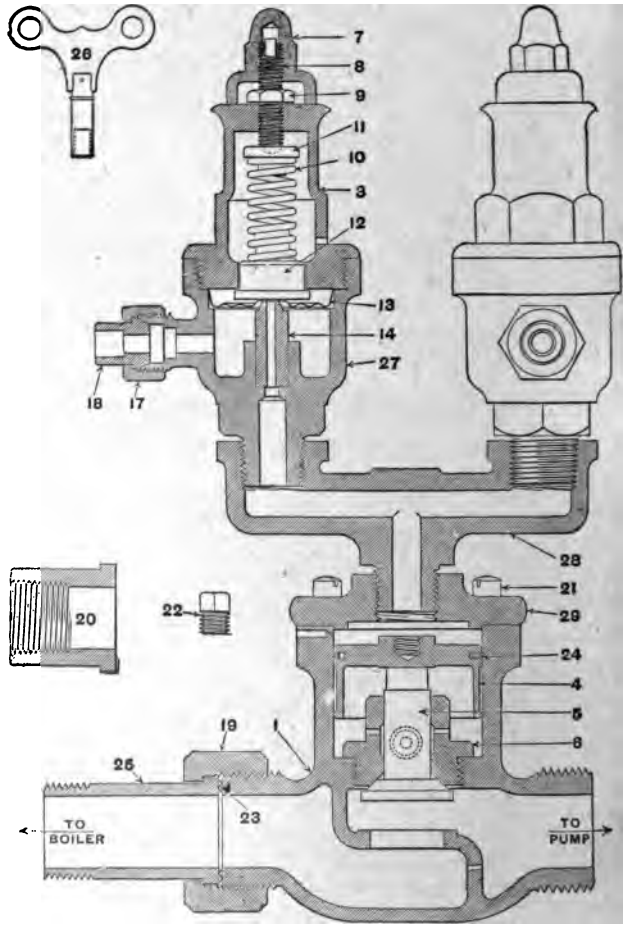
	No.
lve Body. (Specify Style A or C.)	14 Air Valve Seat.
Chamber (includes No 16).	16 Air Union Stud.
ısing.	17 Air Union Nut.
cludes No. 24).	18 Air Union Swivel.
lve.	*19 Steam Union Nut. (Specify Style A or C.)
lve Guide.	*20 Steam Union Swivel. (Specify Style A or C.)
	21 Screw (6 pieces).
Screw.	22 Drain Plug.
	*23 Steam Union Gasket. (Specify Style A or C.)
ıg Spring.	24 Piston Ring.
ring Washer.	25 Steam Union Swivel (Style B only).
m Button.	26 Key.
m.	

.—Pump Governors are furnished in **Three Styles.** Orders for **Complete** Governors, or **Parts,** Nos. 1, 19, 20, and 23, must always specify **Which Style,** the **Plate,** the **Number,** f piece wanted.

E **"A."** ¾" Governor for New York No. 1 Pump or Westinghouse 6" or 8" Pump.
E **"B."** 1" Governor for New York No. 2 Pump.
E **"C."** 1" Governor for Westinghouse 9½" Pump.
, 19, and 23 are exactly alike for Governors Style A and Style B, and No. 20 is not used in rnor, see No. 25."

Duplex Governor.

PLATE Q 2.



NOTE.—These Governors are furnished in **Three Styles.**—See "Note" on opposite pa

Duplex Governor.

8 shows the Duplex Governor, which is used when special conditions of service able to carry the standard train line pressure of 70 pounds in ordinary service, pressure when descending long grades with fully loaded trains. It can also it is desirable to control the pump by both train line and main reservoir

hand portion is adjusted to operate at the low or normal train line pressure, and the rtion at the high (train line or main reservoir) pressure. When both parts are he train line, a ¼" Cut-out Cock (Fig. 5, Plate Q 34) must be placed in the pipe low pressure, or left hand, part of the governor. This cock must be closed when carry the high pressure.

peration of this governor is the same as the standard style, Plate Q 7, it is unnecessescribe its action. (See page 37.)

Parts of Duplex Governor.

PLATE Q 8.

No.	
	e Body. (Specify Style A or C.)
	ing (2 pieces).
	udes No. 24).
	e.
	e Guide.
	es).
	Screw (2 pieces).
	pieces).
	Spring (2 pieces).
	ng Washer (2 pieces).
	Button (2 pieces).
	(2 pieces).
	Seat (2 pieces).
	Nut (2 pieces).
18	Air Union Swivel (2 pieces).
*19	Steam Union Nut. (Specify Style A or C.)
*20	Steam Union Swivel. (Specify Style A or C.)
21	Screw (6 pieces).
22	Drain Plug.
*23	Steam Union Gasket. (Specify Style A or C.)
24	Piston Ring.
25	Steam Union Swivel (Style B only).
26	Key
27	Diaphragm Body (2 pieces).
28	Siamese Fitting.
29	Cylinder Cap.

Pump Governors are furnished in **Three Styles.** Orders for **Complete** Governors, or rts, Nos. 1, 19, 20, and 23, must always specify **Which Style,** the **Plate,** the **Number,** piece wanted.

"**A.**" ¾" Governor for New York No. 1 Pump or Westinghouse 6" or 8" Pump.
"**B.**" 1" Governor for New York No. 2 Pump.
"**C.**" 1" Governor for Westinghouse 9½" Pump.

19, and 23 are exactly alike for Governors Style A and Style B, and No. 20 is not used in or, see No. 25."

Details of Brake Apparatus.

FOR LOCOMOTIVE AND TENDER.

PLATE Q 9.

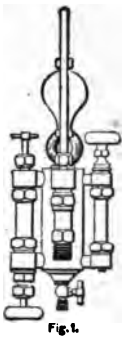


Fig. 1.

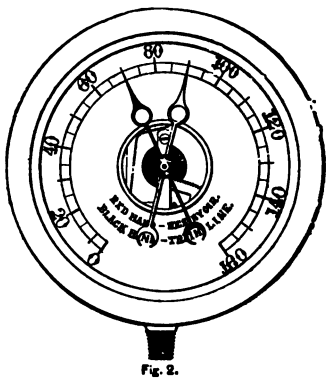


Fig. 2.

Fig. 3

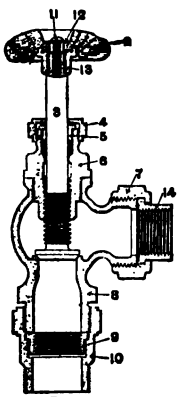


Fig. 4

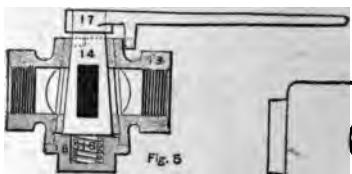


Fig. 5

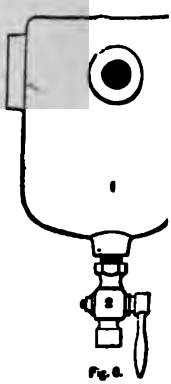


Fig. 6.

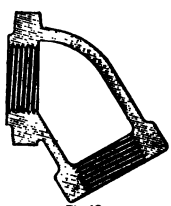


Fig. 12

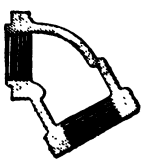


Fig. 8.

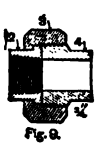


Fig. 9.

Fig. 10.

Fig. 11

Details of Brake Apparatus.

FOR LOCOMOTIVE AND TENDER.

PLATE Q 9.

FIG. 1.

Air Pump Lubricator.

FIG. 2.

Duplex Air Gauge.

FIG. 3.

¾ inch Steam Valve Complete. Used with No. 1 Pump.

DETAILS.

1 Hand Wheel.
2 Valve Stem.
4 Packing Nut.
5 Packing Gland.
6 Neck Piece.
7 Union Nut.
8 Valve Body.
*9 Union Swivel.
10 Valve Stud.
11 Screw.
12 Washer.
13 Socket.
14 Steam-pipe Swivel Ring.

FIG. 4.

1 inch Steam Valve Complete. Used with No. 2 Pump.

DETAILS.

2 Hand Wheel.
3 Valve Stem.
4 Packing Nut.
5 Packing Gland.
6 Neck Piece.
7 Union Nut.
8 Valve Body.
*9 Union Swivel.
*10 Valve Stud.
11 Screw.
12 Washer.
13 Socket.
14 Steam-pipe Swivel.

* Are not included with new valves taken direct.

FIG. 5.

1 inch Cut-out Cock Complete.

DETAILS.

13 Body.
14 Plug.
15 Nut.
16 Spring.
17 Handle.

FIG. 6.

Tender Drain Cup Complete.

DETAILS.

1 Tender Drain Cup.
2 Drain Cock.

NOTE.—This is regularly tapped for 1" pipe. It can be tapped for 1½" pipe, if so specified.

FIG. 8.

1x1¼ inch Angle Fitting.

FIG. 9.

¾ inch Reservoir Union Complete.

DETAILS.

2 Union Swivel.
3 Union Nut.
4 Union Stud.

FIG. 10.

1 inch Reservoir Union Complete.

DETAILS.

2 Union Swivel.
3 Union Nut.
4 Union Stud.

FIG. 11.

1½ inch Reservoir Union Complete.

DETAILS.

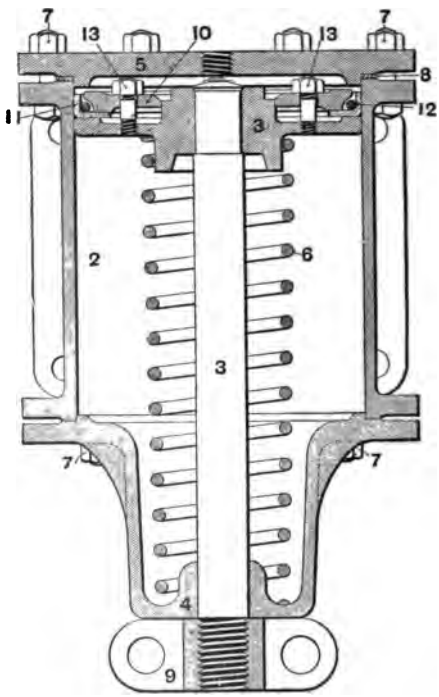
2 Union Swivel.
3 Union Nut.
4 Union Stud.

FIG. 12.

1¼x1¼ inch Angle Fitting.

Push Down Driver Brake Cylinder.

PLATE Q 10.



ush Down Driver Brake Cylinders.

PLATE Q 10.

OUTER FLANGES FULL.				OUTER FLANGES REMOVED.
DIA.			STROKE.	
6	inches	x	6 inches	
6	"	x	8 "	
8	"	x	6 "	
8	"	x	7 "	
8	"	x	10 "	
8	"	x	12 "	Any size will be furnished with outer flanges removed, if ordered that way.
10	"	x	6 "	
10	"	x	8 "	
10	"	x	10 "	
10	"	x	12 "	
12	"	x	8 "	
12	"	x	10 "	
12	"	x	12 "	
14	"	x	10 "	
14	"	x	12 "	

The *outside length* of cylinder body No. 2 is always about 2 *inches more* than the actual stroke given here, as the piston occupies 2 inches.

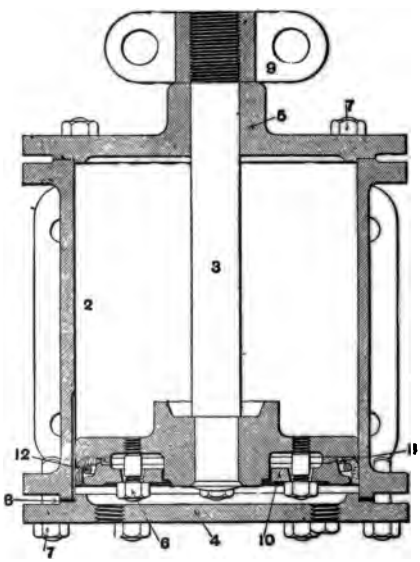
DETAILS.

er Body.
and Rod (includes No. 13).
Head:
lead.
e Spring.
er-head Bolt and Nut.

No.
9 Cross Head. (Select style from Plate Q 17.)
10 Follower.
11 Packing Leather.
12 Expander.
13 Follower Stud and Nut.

Push Up Driver Brake Cylinder.

PLATE Q 11.



Push Up Driver Brake Cylinders.

PLATE Q 11.

NDARD
ZES.

OUTER FLANGES FULL.				OUTER FLANGES REMOVED.
DIA.		STROKE.		
6	inches x	6	inches	Any size will be furnished with outer flanges removed, if ordered that way.
6	" x	8	"	
8	" x	6	"	
8	" x	7	"	
8	" x	10	"	
8	" x	12	"	
10	" x	6	"	
10	" x	8	"	
10	" x	10	"	
10	" x	12	"	
12	" x	8	"	
12	" x	10	"	
12	" x	12	"	
14	" x	10	"	
14	" x	12	"	

The *outside length* of cylinder body No. 2 is always about 2 *inches more* than the actual stroke given here, as the piston occupies 2 inches.

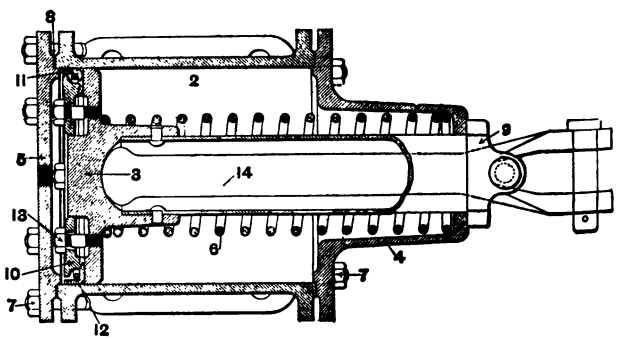
DETAILS

linder Body.	No.
iton and Rod (includes No. 6).	8 Gasket.
it Head.	9 Cross Head. (Select style from Plate Q 17.)
per Head.	10 Follower.
llower Stud and Nut.	11 Packing Leather.
linder-head Bolt and Nut.	12 Expander.

TYPE "B"

Push Driver Brake Cylinder.

PLATE Q 12.



TYPE "B"

Push Driver Brake Cylinders.

PLATE Q 12.

OUTER FLANGES FULL.			OUTER FLANGES REMOVED.
DIA.		STROKE.	
6	inches x	6 inches	
6	" x	8 "	
8	" x	6 "	
8	" x	7 "	
8	" x	10 "	
8	" x	12 "	
10	" x	6 "	
10	" x	8 "	
10	" x	10 "	
10	" x	12 "	
12	" x	8 "	
12	" x	10 "	
12	" x	12 "	
14	" x	10 "	
14	" x	12 "	
16	" x	12 "	

Any size will be furnished with outer flanges removed, if ordered that way.

The *outside length* of cylinder body No. 2 is always about 2 *inches more* than the actual stroke given here, as the piston occupies 2 inches.

DETAILS.

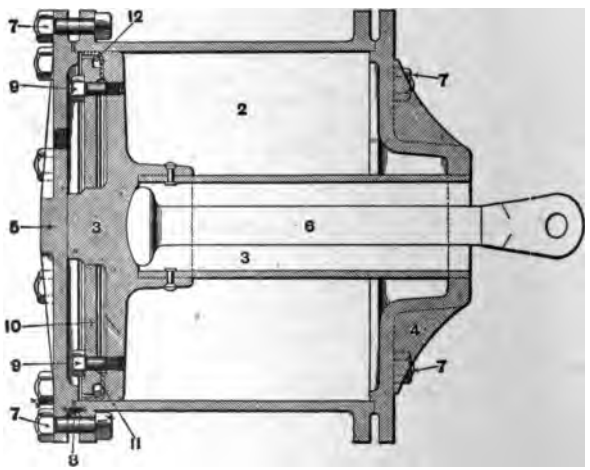
inder Body.
ton and Rod (includes No. 13 only).
ck Head.
t Head.
lease Spring.
inder-head Bolt and Nut.
ket.
sh-rod Holder.

No.
10 Follower.
11 Packing Leather.
12 Expander.
13 Follower Stud and Nut.
14 Push Rod, complete.
15 Oil Plug (not shown).
16 Push-rod Holder Pin, with Cotter.
17 Push-rod Pin, with Cotter.

TYPE "C"

Push Driver Brake Cylinder.

PLATE Q 18.



TYPE "C"

Push Driver Brake Cylinders.

PLATE Q 13.

OUTER FLANGES FULL.				OUTER FLANGES REMOVED.
DIA.		STROKE.		
6	inches	x 6	inches	Any size will be furnished with outer flanges removed, if ordered that way.
6	"	x 8	"	
8	"	x 6	"	
8	"	x 7	"	
8	"	x 10	"	
8	"	x 12	"	
10	"	x 6	"	
10	"	x 8	"	
10	"	x 10	"	
10	"	x 12	"	
12	"	x 8	"	
12	"	x 10	"	
12	"	x 12	"	
14	"	x 10	"	
14	"	x 12	"	
16	"	x 12	"	

ARD
S.

The *outside length* of cylinder body No. 2 is always about 2 *inches more* than the actual stroke given here, as the piston occupies 2 inches.

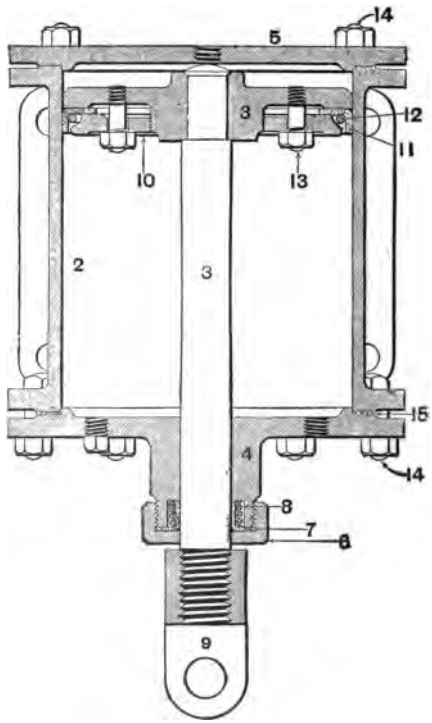
DETAILS.

der Body.
n and Rod (includes No. 9 only).
Head.
Head.
Rod, complete.
der-head Bolt and Nut.

No.
8 Gasket.
9 Follower Stud and Nut.
10 Follower.
11 Packing Leather.
12 Expander.

Pull Up Driver Brake Cylinder.

PLATE Q 14.



Pull Up Driver Brake Cylinders.

PLATE Q 14.

OUTER FLANGES FULL.			OUTER FLANGES REMOVED.
DIA.		STROKE.	
6	inches x	6 inches	
6	" x	8 "	
8	" x	6 "	
8	" x	7 "	
8	" x	10 "	
8	" x	12 "	
10	" x	6 "	Any size will be furnished with outer flanges removed, if ordered that way.
10	" x	8 "	
10	" x	10 "	
10	" x	12 "	
12	" x	8 "	
12	" x	10 "	
12	" x	12 "	
14	" x	10 "	
14	" x	12 "	

The *outside length* of cylinder body No. 2 is always about 2 *inches more* than the actual stroke given here, as the piston occupies 2 inches.

DETAILS.

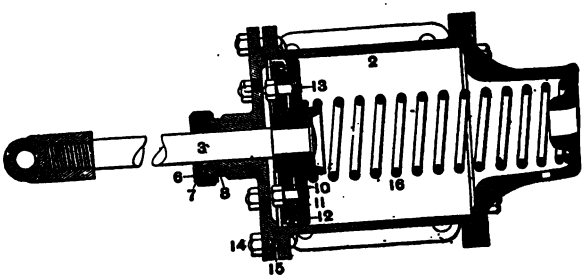
ıder Body.
ın and Rod (includes No. 13).
ing Box Head.
Head.
ing Nut.
Leather.
ing Spring.

No.
9 Cross Head. (Select style from Plate Q 17.)
10 Follower.
11 Packing Leather.
12 Expander.
13 Follower Stud and Nut.
14 Cylinder-head Bolt and Nut.
15 Gasket.

TYPE "A"

Pull Driver Brake Cylinder.

PLATE Q 15.



TYPE "A"

Pull Driver Brake Cylinders.

PLATE Q 15.

OUTER FLANGES PULL				OUTER FLANGES REMOVED
DIA.		STROKE		
6	inches x	6	inches	
6	" x	8	"	
8	" x	6	"	
8	" x	7	"	
8	" x	10	"	
8	" x	12	"	Any size will be furnished with outer flanges removed, if ordered that way
10	" x	6	"	
10	" x	8	"	
10	" x	10	"	
10	" x	12	"	
12	" x	8	"	
12	" x	10	"	
12	" x	12	"	
14	" x	10	"	
14	" x	12	"	

The *outside length* of cylinder body No. 2 is always about 2 *inches more* than the actual stroke given here, as the piston occupies 2 inches.

RD

DETAILS.

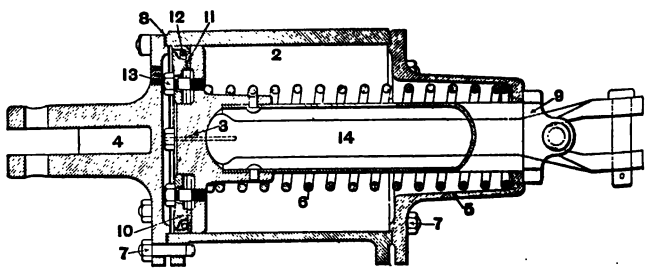
r Body.
and Rod (includes No. 13).
Box Head.
ead.
Nut.
ather.
Spring.
ead. (Select style from Plate 7.)

No.
10 Follower.
11 Packing Leather.
12 Expander.
13 Follower Stud and Nut.
14 Cylinder-head Bolt and Nut.
15 Gasket
16 Release Spring.

TYPE "D"

Engine Truck Brake Cylinder.

PLATE Q 16.



NOTE:—The flexible hose for connecting this cylinder with the pipe leading to the Triple Valve, is shown on Plate Q 34.

TYPE "D"

Engine Truck Brake Cylinders.

PLATE Q 16.

STANDARD SIZES.

DIA.		STROKE.
6 inches	x	6 inches
6 "	x	8 "
8 "	x	7 "
8 "	x	12 "
10 "	x	8 "
10 "	x	10 "
10 "	x	12 "

The *outside length* of cylinder body No. 2 is always about 2 *inches more* than the actual stroke given here, as the piston occupies 2 inches.

DETAILS.

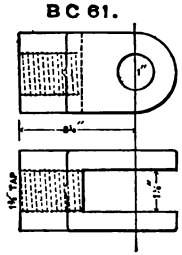
No.
2 Cylinder Body.
3 Piston and Rod (includes No. 13 only).
4 Forked Head.
5 Back Head.
6 Release Spring.
7 Cylinder-head Bolt and Nut.
8 Gasket.
9 Push-rod Holder.

No.
10 Follower.
11 Packing Leather.
12 Expander.
13 Follower Stud and Nut.
14 Push Rod, complete.
15 Oil Plug (not shown).
16 Push-rod Holder Pin, with Cotter.
17 Push-rod Pin, with Cotter.

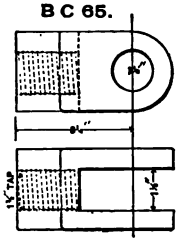
Cross Heads.

PLATE Q 17.

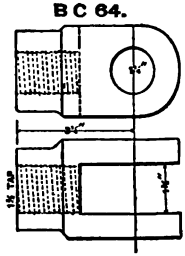
B C 61.



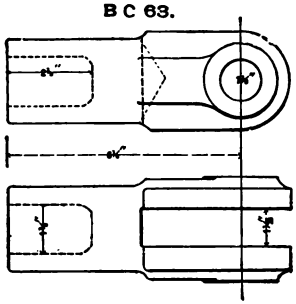
B C 65.



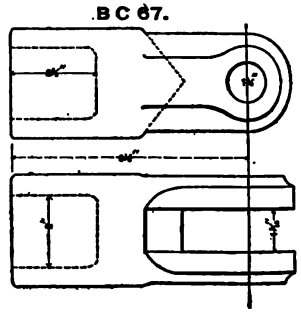
B C 64.



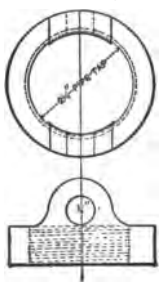
B C 63.



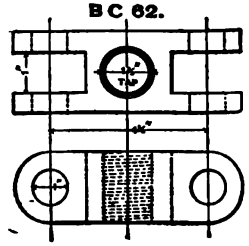
B C 67.



B C 66.



B C 62.



Cross Heads.

PLATE Q 17.

Fig. BC. 61.
Fig. BC. 62.
Fig. BC. 63.
Fig. BC. 64.
Fig. BC. 65.
Fig. BC. 66.
Fig BC. 67

Reservoirs.

PLATE Q 18.

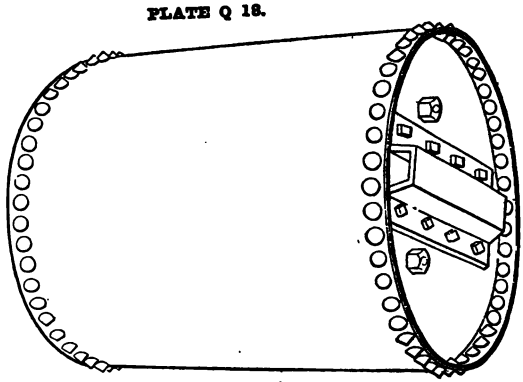


Fig. 1.

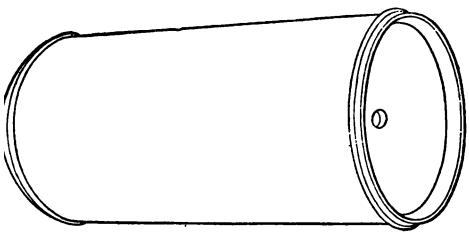


Fig. 2.

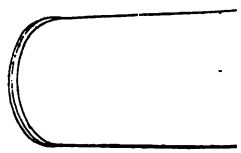


Fig. 5

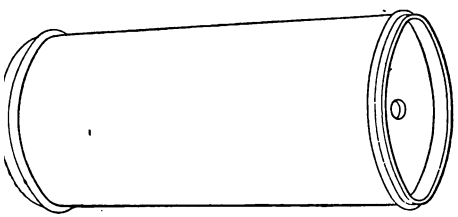


Fig. 3

Fig. 6.

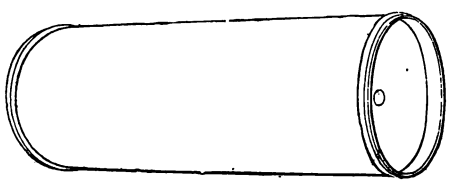


Fig. 4

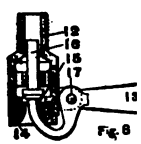


Fig. 8

Reservoirs.

PLATE Q 18.

FIG. 1.
Main Reservoir

16	inches.	x	126	inches,	capacity about	24,000	cubic inches.
18	"	x	100	"	"	24,000	"
20½	"	x	41	"	"	12,000	"
20½	"	x	84	"	"	25,000	"
22½	"	x	34	"	"	11,000	"
22½	"	x	41	"	"	14,000	"
24½	"	x	34	"	"	14,000	"
24½	"	x	41	"	"	17,500	"
26½	"	x	41	"	"	20,000	"
26½	"	x	96	"	"	50,000	"

NOTE.—Main Reservoir capacity for Passenger Engines should not be less than 16,000 cubic es, and for Freight Engines 20,000 to 50,000, according to the number of air brake cars to be handled.

FIG. 2.

16 inch by 33 inch Auxiliary Reservoir. (For use with 14 inch brake cylinders.)

FIG. 3.

14 inch by 33 inch Auxiliary Reservoir. (For use with 12 inch brake cylinders.)

FIG. 4.

12 inch by 33 inch Auxiliary Reservoir. (For use with 10 inch brake cylinders.)

FIG. 5.

10 inch by 24 inch Auxiliary Reservoir. (For use with 8 inch Tender and Truck brake cylinders.)

FIG. 6.

Reservoir Drain Cock.

FIG. 7.

Automatic Drain Cock. (For main reservoir only. For details of this cock, see Plate Q 34, Fig. 7.)

FIG. 8.

10 inch by 33 inch Auxiliary Reservoir. (For use with 8 inch Driver brake cylinders.)

FIG. 9.

16 inch by 42 inch Auxiliary Reservoir. (For use with 16 inch Driver brake cylinders.)

Tender Cylinders.

PLATE Q 19.

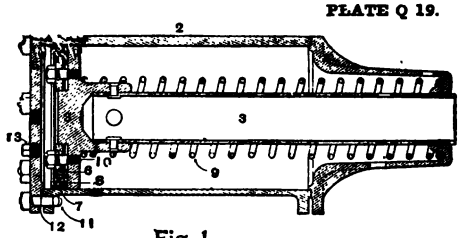


Fig. 1

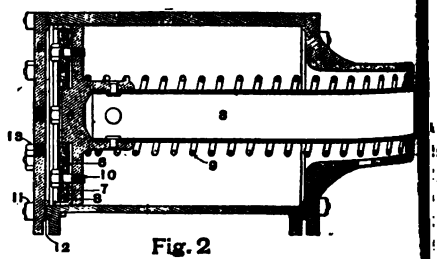


Fig. 2

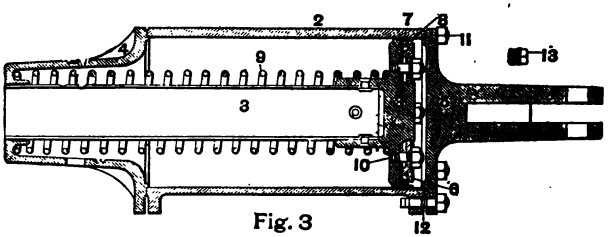


Fig. 3

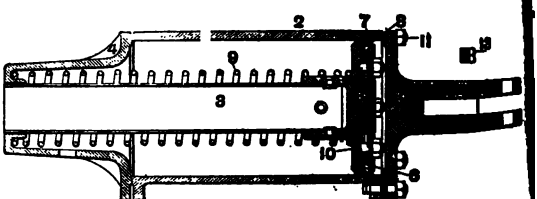


Fig. 4

NOTE.—If, when empty, the Tender weighs 32,000 lbs. or less, use the 8 inch Tender Cylinder and a 10 inch by 24 inch Auxiliary Reservoir. On all Tenders *above* that weight use the 10 inch Tender Cylinder and 12 inch by 33 inch Auxiliary Reservoir. Tenders should have a braking power equal to 90 % of their empty weight.

Tender Cylinders.

PLATE Q 19.

FIG. 1.
Eight-inch Flat Head Tender Cylinder, complete.

FIG. 2.
Ten-inch Flat Head Tender Cylinder, complete.

DETAILS.

	No.	
ıder Body.	8	Expander.
n and Rod (includes No. 10).	9	Release Spring.
Head.	10	Follower Stud and Nut.
Head.	11	Cylinder-head Bolt and Nut.
›wer.	12	Gasket.
ing Leather.	13	Plug.

FIG. 3.
Eight-inch Forked Head Tender Cylinder, complete.

FIG. 4.
Ten-inch Forked Head Tender Cylinder, complete.

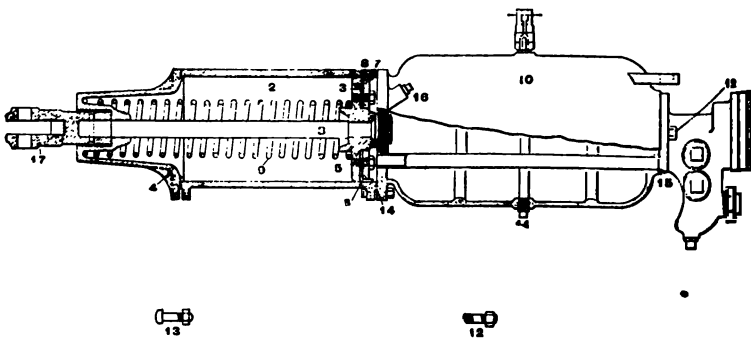
DETAILS.

	No.	
ıder Body.	8	Expander.
n and Rod (includes No. 10).	9	Release Spring.
Head.	10	Follower Stud and Nut.
ed Head. (Specify length wanted.)	11	Cylinder-head Bolt and Nut.
›wer.	12	Gasket.
ng Leather.	13	Plug.

"Special" 8 inch Passenger Car Apparatus.

For Narrow Gauge and Small Passenger Cars, weighing less than 32,000 lbs., when empty, provided the total brake power amounts to 90% of the car weight, and is equally distributed to every wheel

PLATE Q 20.



NOTE :—With this apparatus, the style "P" Triple Valve, Plate Q 6, should be used.

ecial" 8 inch Passenger Car Apparatus.

PLATE Q 20.

o. 1. "Special" Car Cylinder, Reservoir and Triple Valve, complete.

DETAILS.

er Body.
and Rod (includes No. 5).
Head.
er Stud and Nut.
er.
g Leather.
der.
e Spring.

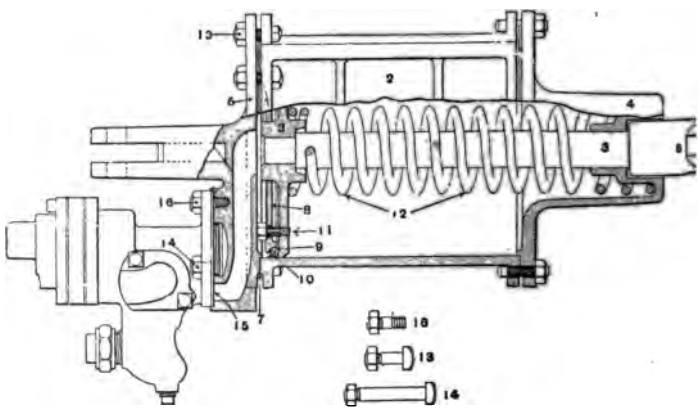
No.
10 Reservoir (includes Nos. 11, 12, and 16).
11 Drain Plug.
12 Reservoir Stud and Nut.
13 Cylinder-head Bolt and Nut.
14 Cylinder Gasket.
15 Triple Valve Gasket.
16 Oil Plug.
17 Cross Head.

For Triple Valve, see Plate Q 6, Style "P."

Twelve Inch Car Cylinder.

For cars weighing, when empty, over 50,000 and not more than 70,000 lbs provided the brake power amounts to 90% of the car weight, and is equally distributed to every wheel.

PLATE Q 22.



NOTE.—The "Special" Triple Valve, Plate Q 24, must be used with this cylinder.

Twelve Inch Car Cylinder.

PLATE Q 22.

No. 1. Twelve inch Car Cylinder, complete.

DETAILS.

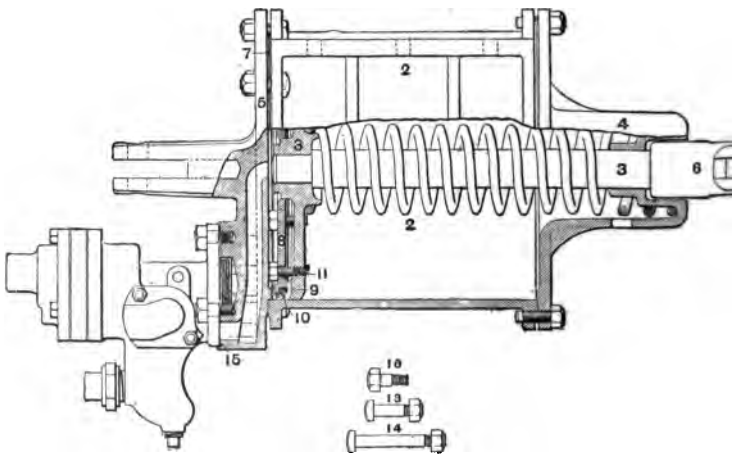
No.	
2	Cylinder Body.
3	Piston and Rod (includes No. 11).
4	Back Head.
5	Forked Head (includes No. 16 and 2 of No. 14).
6	Cross Head.
7	Gasket.
8	Follower.
9	Packing Leather.
10	Expander.
11	Follower Stud and Nut.
12	Release Spring.
13	Cylinder-head Bolt and Nut.
14	Triple-valve Bolt and Nut.
15	Triple-valve Gasket.
16	Triple-valve Stud and Nut.

For Triple Valve, see Plate Q 24.

Fourteen Inch Car Cylinder.

For cars weighing, when empty, over 70,000 lbs., provided the total brake power amounts to 90% of the car weight, and is equally distributed to every wheel.

PLATE Q 23.



NOTE.—The "Special" Triple Valve, Plate Q 24, must be used with this cylinder.

Fourteen Inch Car Cylinder.

PLATE Q 23.

No. 1. Fourteen inch Car Cylinder, complete.

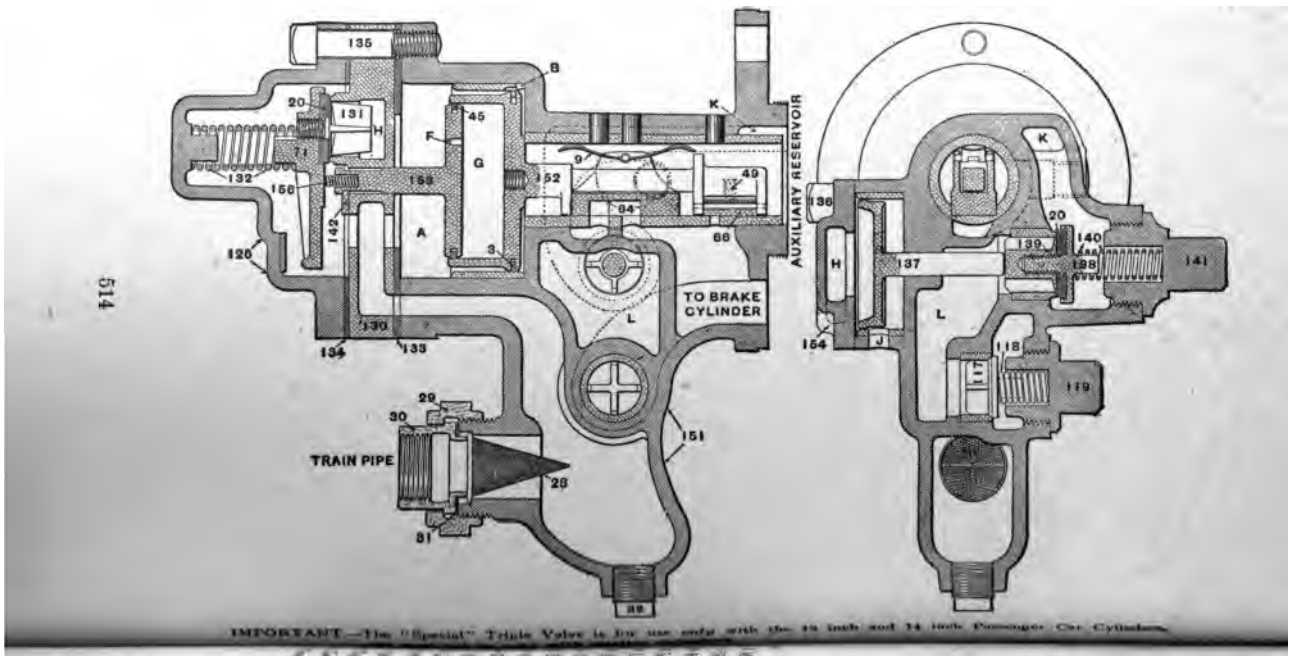
DETAILS.

No.	
2	Cylinder Body.
3	Piston and Rod (includes No. 11)
4	Back Head.
5	Forked Head (includes No. 16, and 2 of No. 14)
6	Cross Head.
7	Gasket.
8	Follower.
9	Packing Leather.
10	Expander.
11	Follower Stud and Nut.
12	Release Spring.
13	Cylinder-head Bolt and Nut.
14	Triple-valve Bolt and Nut.
15	Triple-valve Gasket.
16	Triple-valve Stud and Nut.

For Triple Valve, see Plate Q 24.

"Special" Quick-Action Triple Valve.

PLATE Q 24.



Parts of
Special" Quick-Action Triple Valve.

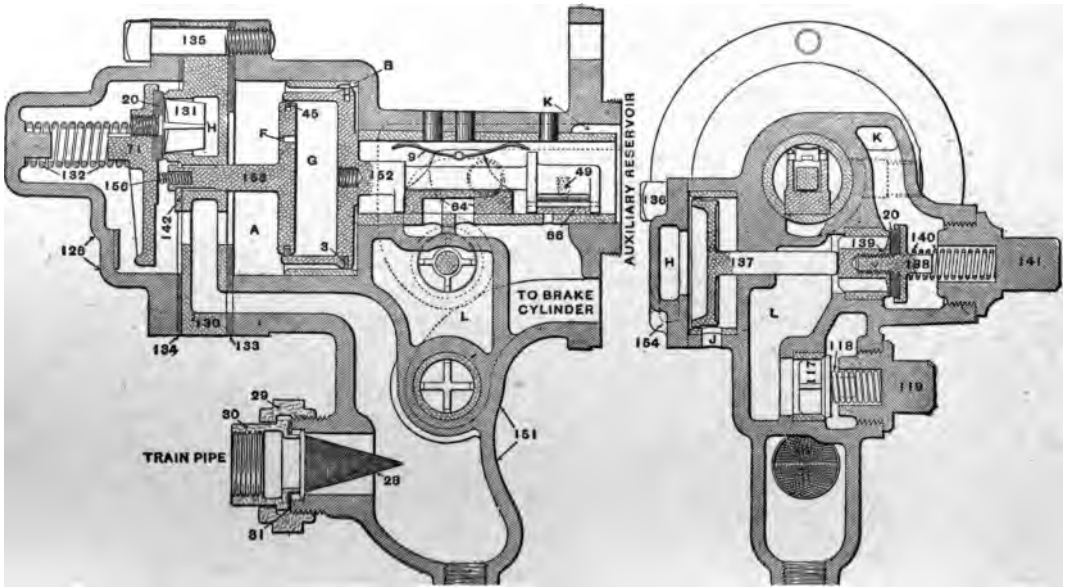
For 12 inch and 14 inch Car Cylinders.

PLATE Q 24.

	No.	
Piston Ring.	130	Vent Valve Seat.
Valve Spring.	132	Vent Valve Spring.
er Valve Seat.	133.	Main Cylinder Gasket.
er.	134	Front Cap Gasket.
Nut.	135	Front Cap Bolt (3 pieces).
Swivel.	136	Side Cap Bolt (2 pieces).
Gasket.	137	Quick Action Valve Piston.
Plug.	138–139–20	Quick Action Valve, complete.
Valve Piston Ring.	140	Quick Action Valve Spring.
ating Valve Spring.	141	Quick Action Valve Cap.
Valve.	142	Piston Stop.
ating Valve.	143	Piston Stop Screw (not shown).
) Vent Valve, complete.	151	Triple Valve Body.
Valve.	152	Main Piston (includes No. 3).
Valve Spring.	153	Vent Valve Piston (includes No. 45).
Valve Cap.	154	Side Cap.
Cap.	156	Vent Valve Piston Spring.

"Special" Quick-Action Triple Valve.

PLATE Q 24.



Parts of
"Special" Quick-Action Triple Valve.

For 12 inch and 14 inch Car Cylinders.

PLATE Q 24.

No.	
	ain Piston Ring.
	ide Valve Spring.
	ubber Valve Seat.
	rainer.
	nion Nut.
	nion Swivel.
	nion Gasket.
	rain Plug.
	ent Valve Piston Ring.
	raduating Valve Spring.
	ide Valve.
	raduating Valve.
	31–20 Vent Valve, complete.
	heck Valve.
	heck Valve Spring.
	heck Valve Cap.
	ront Cap.
130	Vent Valve Seat.
132	Vent Valve Spring.
133.	Main Cylinder Gasket.
134	Front Cap Gasket.
135	Front Cap Bolt (3 pieces).
136	Side Cap Bolt (2 pieces).
137	Quick Action Valve Piston.
138–139–20	Quick Action Valve, complete.
140	Quick Action Valve Spring.
141	Quick Action Valve Cap.
142	Piston Stop.
143	Piston Stop Screw (not shown).
151	Triple Valve Body.
152	Main Piston (includes No. 3).
153	Vent Valve Piston (includes No. 45).
154	Side Cap.
156	Vent Valve Piston Spring.

Details of Passenger Car Brake Apparatus.

PLATE Q 25.

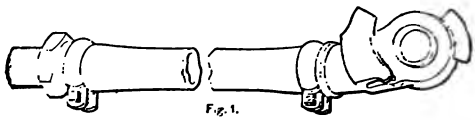


Fig. 1.

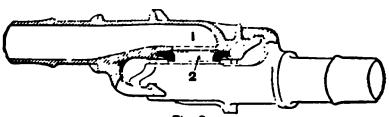


Fig. 2

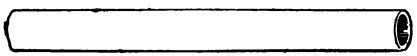


Fig. 3.

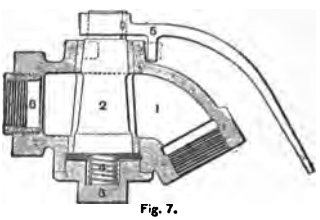


Fig. 7.

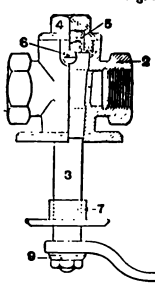


Fig. 9

Fig. 4.

Fig. 5.

Fig. 6

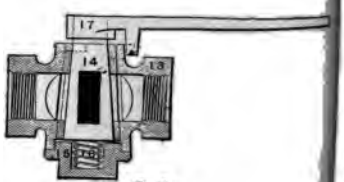


Fig. 8.

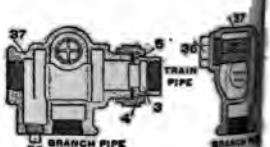


Fig. 10.

Details of Passenger Car Brake Apparatus.

PLATE Q 25.

FIG. 1.

Standard 1 inch Hose and Coupling, complete. (Order in pairs.)

FIG. 2.

No.	
4	Standard 1 inch Coupling. (Order in pairs.)
8	Packing Ring.

FIG. 3.

Standard 1 inch Hose.

FIG. 4.

1 inch by 1¼ inch Hose Nipple.

FIG. 5.

No.	
1	Hose Clamp, 1 inch.
2	Hose-clamp Bolt.

FIG. 6.

1 inch Dummy Coupling.

FIG. 7.

1 inch by 1¼ inch Angle Cock, complete.

No.	DETAILS.
1	Body.
2	Plug.
3	Cap.
4	Spring.
5	Handle.
6	Reducer.

FIG. 8.

1 inch Cut-out Cock, complete.

No.	DETAILS.
13	Body.
14	Plug.
15	Cap.
16	Spring.
17	Handle.

FIG. 9.

No. 1. Conductor's Valve, complete.

No.	DETAILS.
2	Body.
3	Plug.
4	Cap.
5	Spring.
6	Stop.
7	Escutcheon.
8	Handle.
9	Nut.

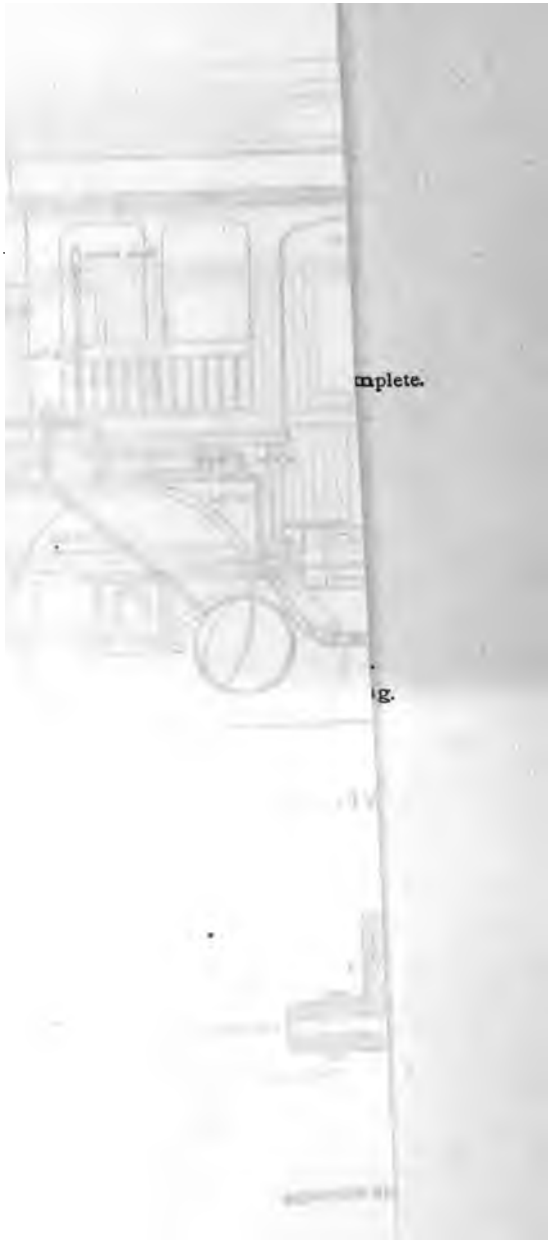
FIG. 10.

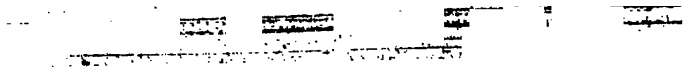
No. 1. 1 inch Car Drain Cup, complete.

No.	DETAILS.
37	Body.
3	Union Swivel.
4	Union Nut.
5	Union Gasket.
35	Strainer.
36	Spider.
32	Plug.

nplete.

g.





Signal Apparatus.

PLATE A 3.

'e, complete.

FIG. 3.

No. 1. Reducing Valve, complete.

No.	DETAILS.
2	Body.
3	Spring Cap.
4	Valve Stud.
5	Supply Valve.
6	Diaphragm Plate.
7	Diaphragm.
8	Diaphragm Nut.
9	Diaphragm Spring.
10	Supply-valve Spring.

)lete.

FIG. 4.

Signal Whistle, complete.

Details of Signal Apparatus.

PLATE Q 26.

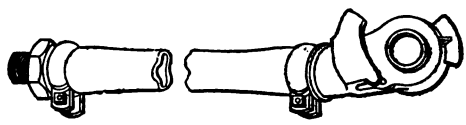


Fig. 1.

Fig. 4.

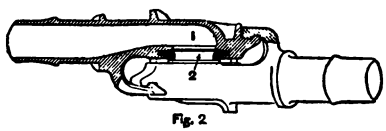


Fig. 2

Fig. 5.

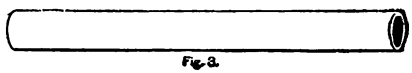


Fig. 3.

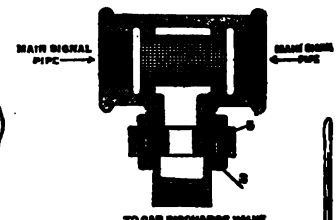


Fig. 7.

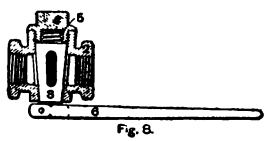


Fig. 8.

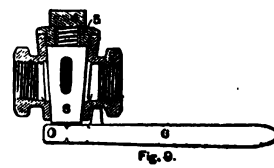


Fig. 9.

Details of Signal Apparatus.

PLATE Q 26.

FIG. 1.

ırd Signal Hose and Coupling, complete. (Order in pairs.)

FIG. 2.

ɔnal Coupling, complete. (Order in pairs.)

cking Ring.

FIG. 3.

Standard Signal Hose.

FIG. 4.

ɔse Clamp.

ɔse-clamp Bolt.

FIG. 5.

1 inch by ¾ inch Hose Nipple.

FIG. 6.

¾ inch Angle Fitting.

FIG. 7.

No. 1. Signal Pipe Strainer, complete.

DETAILS.

No.
2 Body.
3 Union Swivel.
4 Union Nut.
5 Gasket.

FIG. 8.

No. 1. ¾ inch Cut-out Cock, complete.

DETAILS.

No
2 Body
3 Plug.
4 Cap.
5 Spring.
6 Handle.

FIG. 9.

No. 1. ¾ inch Cock, complete.

DETAILS.

No.
2 Body.
3 Plug.
4 Cap.
5 Spring.
6 Handle.

FIG. 10.

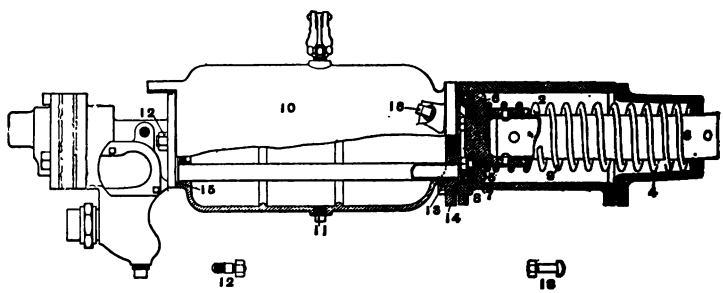
Signal Dummy Coupling.

Narrow Gauge Freight Car Cylinder, Reservoir and Triple Valve.

(6 INCH DIAMETER BY 8 INCH STROKE.)

For cars weighing, when empty, 15,000 lbs. or less, provided the total brake power amounts to 70% of the car weight, and is equally distributed to every wheel.

PLATE Q 27.



NOTE.—The Style "F" Triple Valve, Plate Q 6, must be used for this apparatus.

Narrow Gauge Freight Car Cylinder, Reservoir and Triple Valve.

(6 INCH DIAMETER BY 8 INCH STROKE.)

PLATE Q 27.

No. 1. Narrow Gauge Car Cylinder, Reservoir and Triple Valve, complete.

DETAILS.

No.	
	Cylinder Body.
	Piston and Rod (includes No. 5).
	Back Head.
	Follower Stud and Nut.
	Follower.
	Packing Leather.
	Expander.
	Release Spring.
10	Reservoir (includes Nos. 11–12 and 16)
11	Drain Plug.
12	Reservoir Stud and Nut.
13	Cylinder-head Bolt and Nut.
14	Cylinder Gasket.
15	Triple-valve Gasket.
16	Oil Plug.

For Triple Valve, see Plate Q 6, Style P5

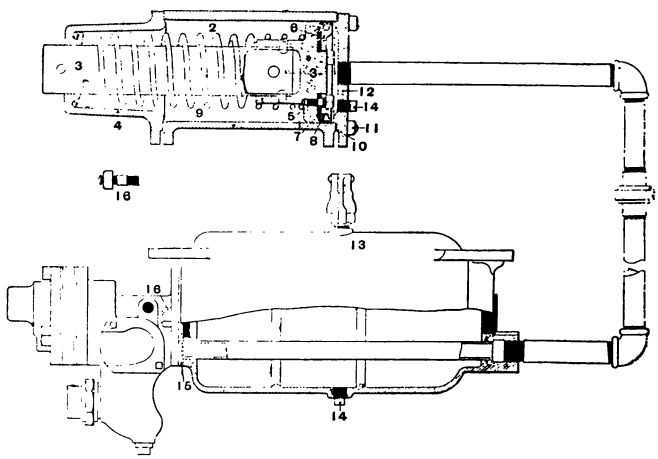
"Special" Narrow Gauge Freight Car Cylinder,

with Detached Auxiliary Reservoir and Triple Valve.

(6 INCH DIAMETER BY 8 INCH STROKE.)

For cars weighing, when empty, 15,000 lbs. or less, provided the total brake power amounts to 70% of the car weight, and is equally distributed to every wheel.

PLATE Q 28.



NOTE.—The Style "F" Triple Valve, Plate Q 6, must be used for this apparatus.

·cial" Narrow Gauge Freight Car Cylinder,

·ith Detached Auxiliary Reservoir and Triple Valve.

(6 INCH DIAMETER BY 8 INCH STROKE.)

PLATE Q 28.

' Narrow Gauge Car Cylinder, with Detached Auxiliary Reservoir and Triple Valve, complete.

DETAILS.

	No.	
Cylinder, complete.	10	Gasket.
·er Body.	11	Cylinder-head Bolt and Nut.
and Rod (includes No. 5).	12	Flat Head.
·lead.	13	Special Auxiliary Reservoir (includes Nos. 14 and 16).
·er Stud and Nut.	14	Drain Plug.
·er.	15	Triple-valve Gasket.
g Leather.	16	Reservoir Stud and Nut.
der.		
e Spring.		

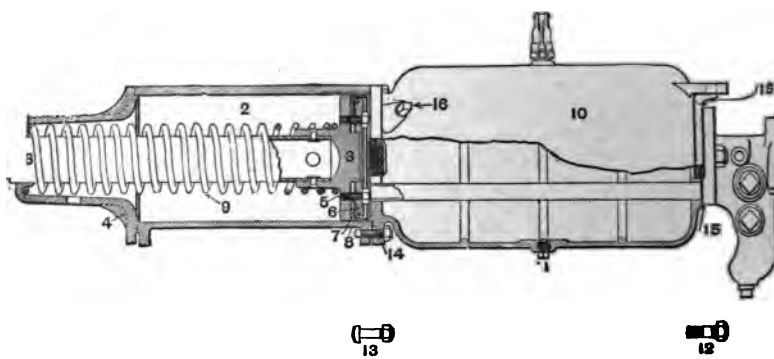
For Triple Valve, see Plate Q 6, Style "F."

Standard Freight Car Cylinder, Reservoir and Triple Valve.

(8 INCH DIAMETER BY 12 INCH STROKE.)

For cars weighing, when empty, over 15,000 and not more than 40,000 lbs., provided the total brake power amounts to 70% of the car weight, and is equally distributed to every wheel.

PLATE Q 29.



NOTE.—The style "F" Triple Valve, Plate Q 6, must be used for this apparatus.

Standard Freight Car Cylinder, Reservoir and Triple Valve.

(8 INCH DIAMETER BY 12 INCH STROKE.)

PLATE Q 29.

No. 1. Standard Freight Cylinder, Reservoir and Triple Valve, complete.

DETAILS.

No.	
2	Cylinder Body.
3	Piston and Rod (includes No. 5).
4	Back Head.
5	Follower Stud and Nut.
6	Follower.
7	Packing Leather.
8	Expander.
9	Release Spring.

No.	
10	Reservoir (includes Nos. 11–19 and 16).
11	Drain Plug.
12	Reservoir Stud and Nut.
13	Cylinder-head Bolt and Nut.
14	Cylinder Gasket.
15	Triple-valve Gasket.
16	Oil Plug.

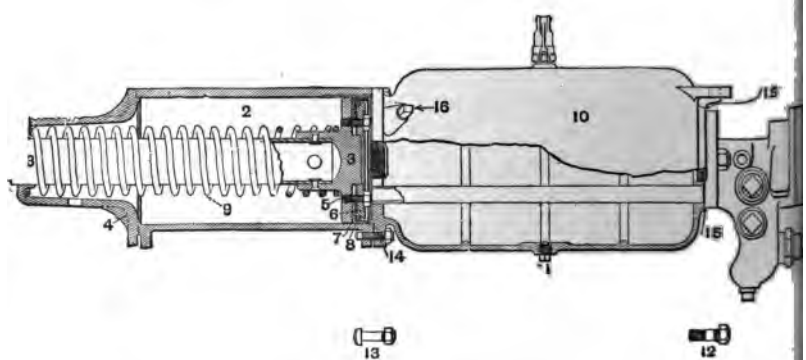
For Triple Valve, see Plate Q 6, Style "F"

Standard Freight Car Cylinder, Reservoir and Triple Valve.

(8 INCH DIAMETER BY 12 INCH STROKE.)

For cars weighing, when empty, over 15,000 and not more than 40,000 lbs., provided the total brake power amounts to 70% of the car weight, and is equally distributed to every wheel.

PLATE Q 29.



NOTE.—The style "F" Triple Valve, Plate Q 6, must be used for this apparatus.

Standard Freight Car Cylinder, Reservoir and Triple Valve.

(8 INCH DIAMETER BY 12 INCH STROKE.)

PLATE Q 29.

No. 1. Standard Freight Cylinder, Reservoir and Triple Valve, complete.

DETAILS.

No.	
2	Cylinder Body.
3	Piston and Rod (includes No. 5).
4	Back Head.
5	Follower Stud and Nut.
6	Follower.
7	Packing Leather.
8	Expander.
9	Release Spring.
10	Reservoir (includes Nos. 11–19 and 16).
11	Drain Plug.
12	Reservoir Stud and Nut.
13	Cylinder-head Bolt and Nut.
14	Cylinder Gasket.
15	Triple-valve Gasket.
16	Oil Plug.

For Triple Valve, see Plate Q 6, Style "F"

"Standard Special" Freight Car Cylinder

with Detached Auxiliary Reservoir and Triple Valve.

(8 INCH DIAMETER BY 12 INCH STROKE.)

For cars weighing, when empty, over 15,000 and not more than 40,000 lbs., provided total brake power amounts to 70% of the car weight, and is equally distributed to every wheel.

PLATE Q 30.

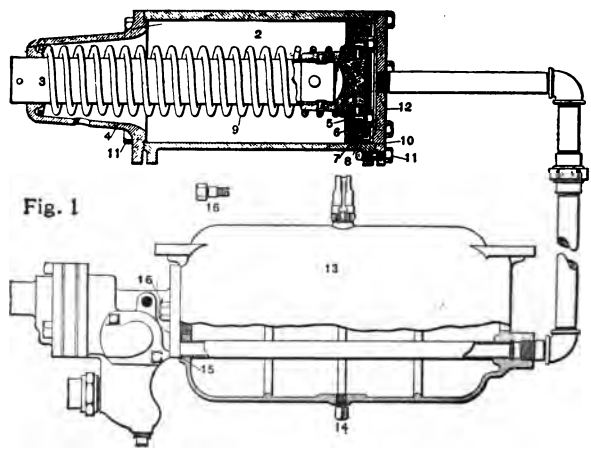


Fig. 1

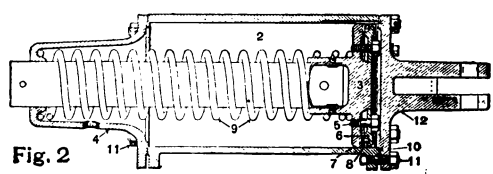


Fig. 2

andard Special" Freight Car Cylinder,

ith Detached Auxiliary Reservoir and Triple Valve.

(8 INCH DIAMETER BY 12 INCH STROKE.)

PLATE Q 30.

Standard Freight Cylinder, with Detached Auxiliary Reservoir and Triple Valve, complete.

DETAILS.

	No.	
Cylinder, complete.	10	Gasket.
r Body.	11	Cylinder-head Bolt and Nut.
and Rod (includes No. 5).	12	Flat Head.
lead.	13	Special Auxiliary Reservoir (includes Nos. 14 and 16).
er Stud and Nut.	14	Drain Plug.
er.	15	Triple-valve Gasket.
g Leather.	16	Reservoir Stud and Nut.
ler.		
Spring.		

For Triple Valve, see Plate Q 6, Style "F."

Fig. 2. Forked Head Brake Cylinder, complete.

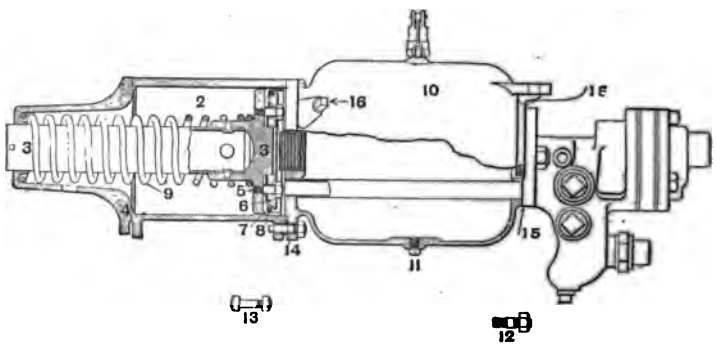
DETAILS.

	No.	
r Body.	8	Expander.
and Rod (includes No. 5).	9	Release Spring.
lead.	10	Gasket.
er Stud and Nut.	11	Cylinder-head Bolt and Nut.
er.	12	Forked Head.
g Leather.		

"Special" Freight Car Cylinder, Reservoir and Triple Valve.

(8 INCH DIAMETER BY 8 INCH STROKE).

PLATE Q 31.



NOTE.—This Cylinder and Reservoir should only be used where it is not possible to apply the apparatus shown on Plates Q 29 and 30. They develop as much power, but the stroke is shorter.

The Style "F" Triple Valve, Plate Q 6, must be used for this apparatus.

"Special" Freight Car Cylinder, Reservoir and Triple Valve.

(8 INCH DIAMETER BY 8 INCH STROKE.)

PLATE Q 31.

No. 1. "Special" Freight Cylinder and Reservoir, with Triple Valve, complete.

DETAILS.

No.	
2	Cylinder Body.
3	Piston and Rod (includes No. 5).
4	Back Head.
5	Follower Stud and Nut.
6	Follower.
7	Packing Leather.
8	Expander.
9	Release Spring.
10	Reservoir (includes Nos. 11-12 and 16).
11	Drain Plug.
12	Reservoir Stud and Nut.
13	Cylinder-head Bolt and Nut.
14	Cylinder Gasket.
15	Triple-valve Gasket.
16	Oil Plug.

For Triple Valve, see Plate Q 6, Style "F."

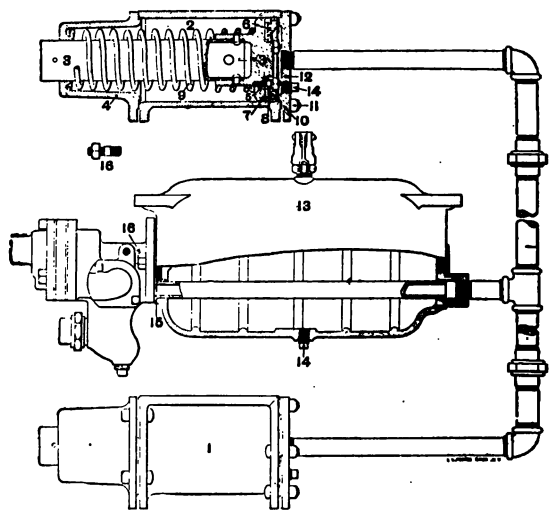
"Twin Cylinder" Freight Car Brake Apparatus,

with Detached Auxiliary Reservoir and Triple Valve.

(8-INCH DIAMETER BY 8 INCH STROKE.)

For cars weighing, when empty, over 15,000 and not more than 40,000 lbs., provided the total brake power amounts to 70% of the car weight, and is equally distributed to every wheel.

PLATE Q 32.



NOTE.—The Twin Cylinder equipment is only for use upon freight cars which are so constructed that the standard single cylinder brake cannot be used. The cylinders are usually so placed that one is near each truck. Larger sizes can be furnished if necessary

The Style "F" Triple Valve, Plate Q 6, must be used for this apparatus

ı Cylinder" Freight Car Brake Apparatus,

ıith Detached Auxiliary Reservoir and Triple Valve.

(6 INCH DIAMETER BY 8 INCH STROKE.)

PLATE Q 32.

ylinder" Freight Car Apparatus: Cylinders with Detached Auxiliary Reservoir and Triple Valve, complete.

DETAILS.

Cylinder, complete.	No.
ıer Body.	10 Gasket.
and Rod (includes No. 5).	11 Cylinder-head Bolt and Nut.
Head.	12 Flat Head.
ıer Stud and Nut.	13 Special Auxiliary Reservoir (includes Nos. 14 and 16).
ıer.	14 Drain Plug.
g Leather.	15 Triple-valve Gasket.
der.	16 Reservoir Stud and Nut.
e Spring.	

For Triple Valve, see Plate Q 6, Style "F"

Details of Freight Car Brake Apparatus.

PLATE Q 33.

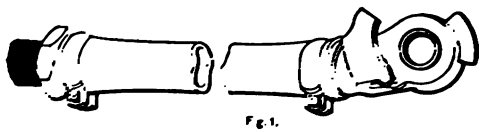


Fig. 1.

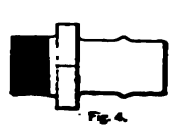


Fig. 4.

Fig. 5

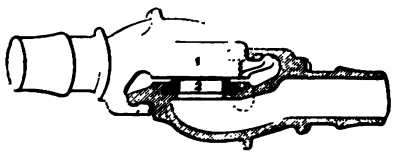


Fig. 2.

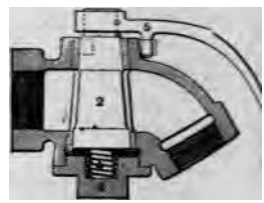


Fig. 6.

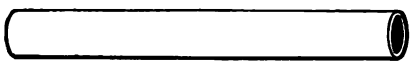


Fig. 3.

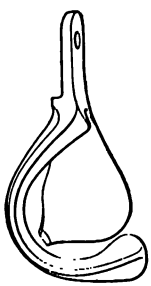


Fig. 8

Fig. 13

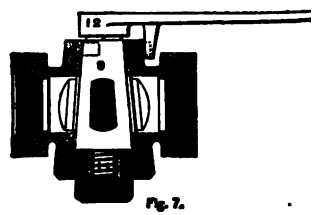


Fig. 7.

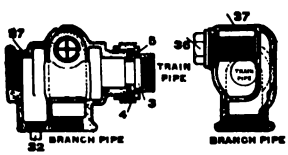


Fig. 9.

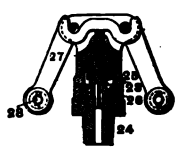


Fig. 10.

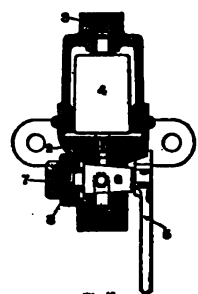


Fig. 11

For Special Drain Cup, see Plate Q 34.

Details of Freight Car Brake Apparatus.

PLATE Q 33.

FIG. 1.

inch Hose and Coupling, complete.
(Order in Pairs.)

FIG. 2.

Standard 1¼ inch Coupling.
(Order in Pairs.)
Packing Ring.

FIG. 3.

Standard 1¼ inch Hose.

FIG. 4.

1¼ inch Hose Nipple.

FIG. 5.

1¼ inch Hose Clamp.
Hose-clamp Bolt.

FIG. 6.

nch Angle Cock, complete.

DETAILS.

No.	
1	Body.
2	Plug.
3	Cap.
4	Spring.
5	Handle.

FIG. 7.

nch Cut-out Cock, complete.

DETAILS.

No.	
8	Body.
9	Plug.
10	Cap.
11	Spring.
12	Handle.

FIG. 8.

nch Coupling Hook. (See Fig. 13.)

FIG. 9.

No. 1. 1¼ inch Drain Cup, complete.

DETAILS.

No.	
37	Body.
3	Union Swivel.
4	Union Nut.
5	Gasket.
35	Strainer.
36	Spider.
32	Plug.

FIG. 10.

Release Valve, complete.

DETAILS.

No.	
23	Cylinder.
24	Stud.
25	Vent Valve.
26	Spring.
27	Handle.
28	Pin.
29	Cotter

FIG. 11.

Pressure Retaining Valve, complete.

DETAILS.

No.	
2	Body (includes Nos. 5–6–7 and 8)
3	Case.
4	Weight.
5	Handle.
6	Plug.
7	Cap.
8	Spring.

FIG. 12.

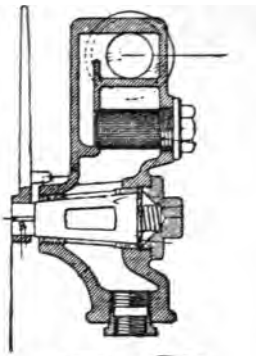
Coupling Groove Cleaning Tool.

FIG. 13.

1¼ inch Dummy Coupling.

Extra Details

Plate Q 34.



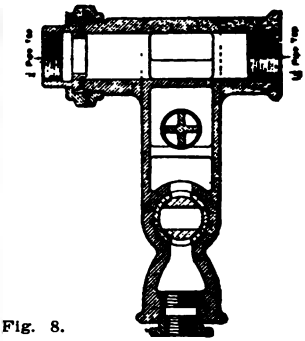


Fig. 8.

Fig. 9.

Fig. 10

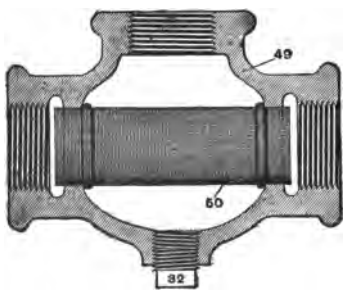


Fig. 1.

Fig. 2.

Fig. 11.

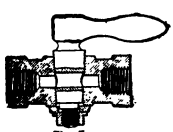


Fig. 5.

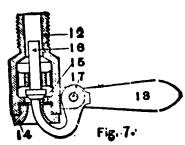


Fig. 7.

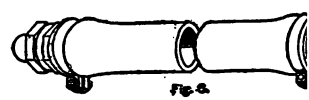


Fig. 6.

Extra Details.

PLATE Q 34.

FIG. 1.

cial Drain Cup, complete. (See the Note below.)

DETAILS.

No.	
49	Body.
50	Strainer.
32	Drain Plug.

FIG. 2.

Safety Valve, complete.

DETAILS.

No.	
2	Body.
3	Regulating Nut.
4	Cap.
5	Spring.
6	Valve.

FIG. 5.

¼-inch Cut-out Cock for Duplex Governor

FIG. 6.

Special Hose Connection, for use with Engine Truck Brakes.

FIG. 7.

Automatic Drain Cock, complete (for Main Reservoir).

DETAILS.

No.	
12	Body.
13	Handle.
14	Cap.
15	Valve Seat.
16	Valve.
17	Pin.

Fig. 8.

*Combined Brake Pipe Strainer and Cut-out Cock Complete.

Fig. 9.

†Self-Locking Angle Cock Locked Open.

Fig. 10.

†Self-Locking Angle Cock Unlocked.

Fig. 11.

†Self-Locking Angle Cock Locked Closed.

*This combined Strainer and Cut-out Cock is claimed to avoid delays o trains caused by broken cross over pipes, will protect triple valve nd brake cylinder from dirt and scale of the brake pipe. It will liminate two pipe joints per car.

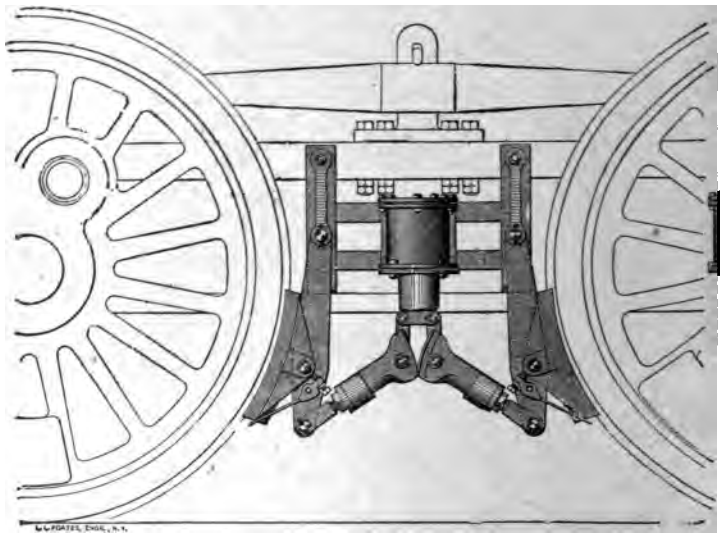
†This angle cock locks absolutely in both open and closed positions. he handle must be raised and moved by hand to change it from one osition to the other. The old style angle cock may be converted to he "Self-Locking type," by simply substituting self-locking handles.

NOTE.—Our standard drain cup (Fig. 9, Plate Q 33) should be used in all cases where it can be d in the normal position, *i. e.*, with the branch pipe opening at the bottom.

On some hopper-bottom cars, however, where the detached cylinder has to be placed high up end under the hopper, it often becomes necessary to place the drain cup in an inverted position, the branch pipe led from the top. In such cases, the Special Drain Cup must be used, as our ard drain cup will not work well when inverted.

Cam Driving Wheel Brake.

STYLE A.



STYLES OF DRIVER BRAKES.

FOR EIGHT WHEEL PASSENGER ENGINES, AND FOUR WHEEL SWITCHERS.

STYLE A. Cam Spread Brake as above, on two pairs of wheels.

STYLE H. Outside Equalized Pull Brake, on forward side of two pairs of wh
See opposite page.

FOR TEN WHEELERS, MOGULS AND SIX WHEEL SWITCHERS.

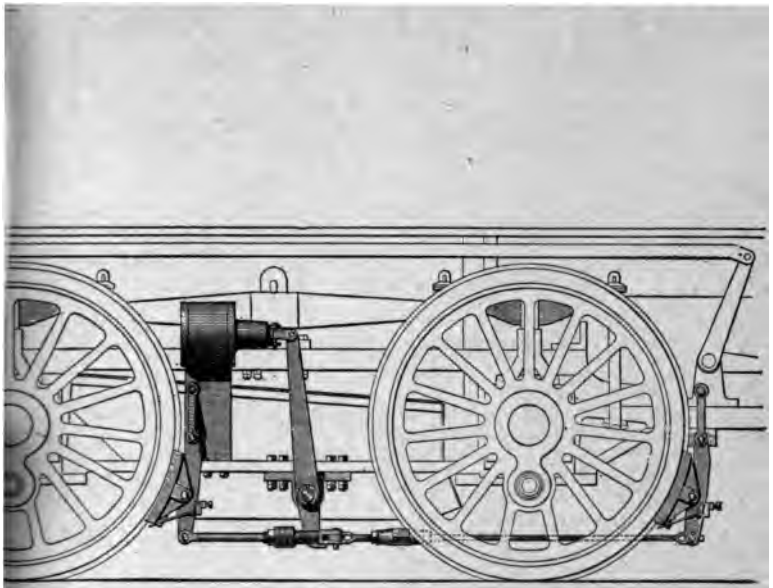
STYLE F. See opposite page.

FOR CONSOLIDATION ENGINES.

STYLE G. Same as opposite page, except on four pairs of wheels.

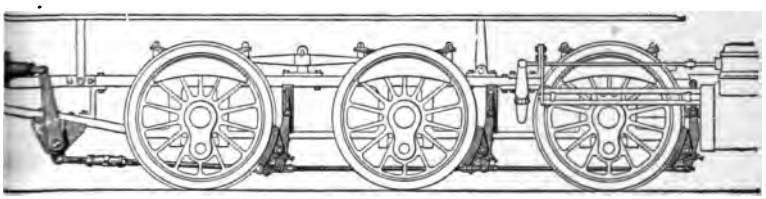
FOR THE FRONT TRUCK OF ENGINE.

STYLE K. Engine Truck Brake Fixtures (Levers, Shoes, etc.).



STYLE H.

Outside Equalized Brake on 2 Pairs of Driving Wheels.



STYLE F.

Outside Equalized Brake on 3 Pairs of Driving Wheels.

Schedules of Equipments.

SCHEDULE E 1. Locomotive Equipment *without* Driver Brake Apparatus; for Locomoti provided with brakes acting upon the Driving Wheels:

1 No. 2 Duplex Air Pump, complete with Oil Cups, Drain Cock, and Wrenches.
1 Positive Discharge Engineer's Brake Valve, complete with Supplementary R and 1 inch Cut-out Cock.
1 1 inch Pump Governor (Plate Q 7, Style B).
1 1 inch Steam Valve.
1 Duplex Air Gauge.
1 1 inch Reservoir Union.
1 1¼ inch Reservoir Union.
1 Automatic Drain Cock for Main Reservoir.
1 Pair 1 inch x 22 inch Complete Coupling Hose.
2 1 inch x 1¼ inch Angle Fittings.
1 1 inch Stop Cock.
1 1 inch Dummy Coupling.

SCHEDULE E 2. Full Locomotive Equipment, including parts for operating Driving Wheel corresponding to Westinghouse Schedule A 1. This equipment is Schedule E 1, with the following parts added

2 Driver Brake Cylinders of suitable size and kind.
1 Auxiliary Reservoir of size required.
1 Reservoir Drain Cock.
1 Triple Valve (Plate Q 4 or Q 5) with Bracket and Nipple.
1 ½ inch Cut-out Cock.
1 1 inch Drain Cup.

SCHEDULE E 3. **Tender Equipment,** corresponding to Westinghouse Schedule B 1

1 Tender Brake Cylinder of size and kind required.
1 Auxiliary Reservoir of size required.
1 Reservoir Drain Cock.
1 Triple Valve (Plate Q 4) with Bracket and Nipple.
1 ¾ inch Cut-out Cock.
1 1 inch Tender Drain Cup complete with Drain Cock.
1 1¼ inch Angle Cock with 1 inch Reducer.
1 Pair 1 inch x 22 inch Complete Coupling Hose.
1 1 inch x 1¼ inch Angle Fitting.
1 1 inch Dummy Coupling.

SCHEDULE D A. **Driver Brake Apparatus** (parts to operate Driving Wheel Brakes when the latter are added to engines already equipped for operating train brakes only), corresponding to Westinghouse Schedule D 1.

2 Driver Brake Cylinders of suitable size and kind.
1 Auxiliary Reservoir of size required.
1 Reservoir Drain Cock.
1 Triple Valve (Plate Q 4 or Q 5) with Bracket and Nipple.
1 ¾ inch Cut-out Cock.
1 1 inch Drain Cup.

SCHEDULE T A. **Engine Truck Brake Apparatus,** (parts to operate brakes acting upon the Engine Truck Wheels, when the engine is otherwise fully equipped), corresponding to Westinghouse Schedule D 2.

1 Engine Truck Brake Cylinder of size and kind required.
1 Auxiliary Reservoir of size required.
1 Reservoir Drain Cock.
1 Triple Valve (Plate Q 4) with Bracket and Nipple.
1 ¾ inch Cut-out Cock.
1 1 inch Drain Cup.
1 Piece 1 inch x 22 inch Hose with suitable connections.

SCHEDULE P C P. **Parts for Changing Pressure,** similar to Westinghouse Schedule U.

1 Set of parts to change the Standard Governor (Plate Q 7) to a Duplex Governor (Plate Q 8).
1 ¾ inch Cut out Cock for Governor.
2 Safety Valves (one each for driver brake cylinders and tender cylinder). If the engine is equipped with front truck brakes, one more Safety Valve will be furnished for the front truck cylinder.

SCHEDULE E C. **Small Passenger Car Equipment,** for cars weighing less than 32,000 lbs.

1 Special 8 inch Car Cylinder and Reservoir (Plate Q 20), complete with Quick Action T Valve (Plate Q 6, Style P).
1 ¾ inch Conductor's Valve.
1 Pair 1 inch x 22 inch Complete Coupling Hose.
2 1¼ inch Angle Cocks with 1 inch Reducers.
1 1 inch Cut-out Cock.
1 Reservoir Drain Cock.
1 1 inch Car Drain Cup.
2 1 inch Dummy Couplings.

SCHEDULE S C. **Standard Passenger Car Equipment,** (for cars weighing from 32,000 to 50,000 l corresponding to Westinghouse Schedule C 1.

1 10 inch Car Brake Cylinder.
1 12 inch x 33 inch Auxiliary Reservoir.
1 Quick Action Triple Valve (Plate Q 6, Style P), and Gasket No. 15 (Plate Q 21).
1 ¾ inch Conductor's Valve.
1 Pair 1 inch x 22 inch Complete Coupling Hose.
2 1¼ inch Angle Cocks with 1 inch Reducers.
1 1 inch Cut-out Cock.
1 Reservoir Drain Cock.
1 1 inch Car Drain Cup.
2 1 inch Dummy Couplings.

SCHEDULE R C. **Large Passenger Car Equipment,** (for cars weighing over 50,000 and up to 7 lbs.), corresponding to Westinghouse Schedule R.

1 12 inch Car Brake Cylinder.
1 14 inch x 33 inch Auxiliary Reservoir.
1 Special Quick Action Triple Valve (Plate Q 24), and Gasket No. 15 (Plate Q 22).
1 ¾ inch Conductor's Valve.
1 Pair 1 inch x 22 inch Complete Coupling Hose.
2 1¼ inch Angle Cocks with 1 inch Reducers.
1 1 inch Cut-out Cock.
1 Reservoir Drain Cock.
1 1 inch Car Drain Cup.
2 1 inch Dummy Couplings.

SCHEDULE H C. **"Special" Passenger Car Equipment,** (for cars weighing over 70,000 lbs.) responding to Westinghouse Schedule P.

1 14 inch Car Brake Cylinder.
1 16 inch x 33 inch Auxiliary Reservoir.
1 Special Quick Action Triple Valve (Plate Q 24), and Gasket No. 15 (Plate Q 23).
1 ¾ inch Conductor's Valve.
1 Pair 1 inch x 22 inch Complete Coupling Hose.
2 1¼ inch Angle Cocks with 1 inch Reducers.
1 1 inch Cut-out Cock.
1 Reservoir Drain Cock.
1 1 inch Car Drain Cup.
2 1 inch Dummy Couplings.

EDULE F. **"Standard" Freight Car Equipment** (Combined Apparatus) (for cars weighing over 15,000 and not more than 40,000 lbs.), corresponding to Westinghouse Schedule H 1.

Standard Freight Cylinder, Reservoir, and Triple Valve, complete (Plate Q 29).
Pressure Retaining Valve.
Release Valve.
1¼ inch Car Drain Cup.
1¼ inch Angle Cocks.
1¼ inch Cut-out Cock.
Pair 1¼ inch x 22 inch Complete Coupling Hose.

EDULE F. **"Standard Special" Freight Car Equipment** (Detached Apparatus) (for Cars weighing over 15,000 and not more than 40,000 lbs.), corresponding to Westinghouse Schedule H 2.

Freight Cylinder (either Fig. 1 or Fig. 2, Plate Q 30).
Detached Auxiliary Reservoir and Triple Valve (Plate Q 30).
Pressure Retaining Valve.
Release Valve.
1¼ inch Car Drain Cup.
1¼ inch Angle Cocks.
1¼ inch Cut-out Cock.
Pair 1¼ inch x 22 inch Complete Coupling Hose.

EDULE F. **"Special" Freight Car Equipment** (Short Stroke Apparatus) (for use when there is not room for the standard length), corresponding to Westinghouse Schedule H 3.

Short Stroke Cylinder, Reservoir, and Triple Valve, complete (Plate Q 31).
Pressure Retaining Valve.
Release Valve.
1¼ inch Car Drain Cup.
1¼ inch Angle Cocks.
1¼ inch Cut-out Cock.
Pair 1¼ inch x 22 inch Complete Coupling Hose.

ummy Couplings extra, not furnished unless specified; price 16 cents NET per pair for either New or Old style.

DULE F. **"Narrow Gauge" Freight Car Equipment** (Combined Apparatus) (for cars weighing 15,000 lbs. or less), corresponding to Westinghouse Schedule H 4.

Narrow Gauge Freight Cylinder, Reservoir, and Triple Valve, complete (Plate Q 27).
Pressure Retaining Valve.
Release Valve.
1¼ inch Car Drain Cup.
1¼ inch Angle Cocks.
1¼ inch Cut-out Cock.
Pair 1¼ inch x 22 inch Complete Coupling Hose.

SCHEDULE D N F. **"Special Narrow Gauge" Freight Car Equipment** (Detached Apparatus) (f weighing 15,000 lbs. or less). corresponding to Westinghouse Schedule H

1 Special Narrow Gauge Freight Cylinder (Plate Q 28).
1 Special Narrow Gauge Reservoir and Triple Valve, complete (Plate Q 28).
1 Pressure Retaining Valve.
1 Release Valve.
1 1¼ inch Car Drain Cup.
2 1¼ inch Angle Cocks.
1 1¼ inch Cut-out Cock.
1 Pair 1¼ inch x 22 inch Complete Coupling Hose.

SCHEDULE T F. **Twin Cylinder Freight Car Equipment** (Twin Cylinders and Detached Reser (for cars weighing over 15,000 and not more than 40,000 lbs.), correspondi Westinghouse Schedule H 6.

2 Brake Cylinders 6 inch x 8 inch.
1 Standard Detached Reservoir and Triple Valve, complete (Plate Q 32).
1 Pressure Retaining Valve.
1 Release Valve
1 1¼ inch Car Drain Cup.
2 1¼ inch Angle Cocks.
1 1¼ inch Cut-out Cock.
1 Pair 1¼ inch x 22 inch Complete Coupling Hose.

SCHEDULE H F. **"Large" Freight Car Equipment** (for cars weighing over 40,000 lbs.)

1 Brake Cylinder 10 inch x 12 inch (of style required).
1 Auxiliary Reservoir 12 inch x 33 inch.
1 Quick Action Triple Valve (Plate Q 6, Style P) and Gasket.
1 Pressure Retaining Valve.
1 Release Valve.
1 1¼ inch Car Drain Cup.
2 1¼ inch Angle Cocks.
1 1¼ inch Cut-out Cock.
1 Pair 1¼ inch x 22 inch Complete Coupling Hose.

SCHEDULE E S. **Train Signal for Locomotive and Tender,** corresponding to Wes Schedule J.

1 Signal Valve.
1 Reducing Valve.
1 Signal Whistle.
2 Pairs ¾ inch Complete Signal Hose, with Angle Fittings attached.
2 ¾ inch Stop Cocks.
1 ¼ inch Stop Cock.
2 Signal Dummy Couplings

Train Signal for Passenger Car, corresponding to Westinghouse Schedule K.

charge Valve.
ich Complete Signal Hose, with Angle Fittings attached.
top Cocks.
ut-out Cock.
ipe Strainer.
Dummy Couplings.

To Change Locomotive and Tender from Old to New Automatic, corresponding to Westinghouse Schedule L.

Discharge Engineer's Brake Valve, complete with Supplementary Reservoir and
h Cut-out Cock.
Air Gauge.
Reservoir Union.
Cock with 1 inch Reducer.
ich x 22 inch Complete Coupling Hose.
1¼ inch Angle Fittings.
1¼ inch Hose Nipple.
Pipe and Pipe Fittings.

To Change Car From Old to New Automatic, corresponding to Westinghouse Schedule M.

Front Cylinder Head.
4½ inch Bolts.
Action Triple Valve (Plate Q 6, Style P).
Car Drain Cup.
Cut-out Cock.
Cocks with 1 inch Reducers.
1¼ inch Hose Nipples.
Cross Head for 1⅝ inch Pin and Lever.
Pipe and Pipe Fittings.

Usual Quantity of Pipe and Pipe Fittings Required:

ng the Brake to a Locomotive and Tender, including Driver Brakes:

0 ft. 1¼ in. Pipe.
5 " 1 in. "
5 " ½ in. "
5 " ¼ in. "
5 " ⅜ in. Copper Pipe.
5 Nipples, ½ in. x 2 in.
8 Ells, ¼ in.
5 " 1 in.

4 to 6 Ells, ½ in.
1 Tee, 1 in.
1 " 1 in. x 1 in. x ½ in.
1 Coupling, ½ in.
1 or 2 Unions, 1 in.
3 to 6 " ¼ in.
1 " ¾ in.

For applying the Brake to a Passenger Car:

55 to 90 ft. 1 in. Pipe.	1 or 2 Street Ells, 1 in.
15 " 30 " ¾ in. "	1 Tee, 1 in. x 1 in. x
1 or 2 Ells, 1 in.	2 Unions, ¾ in.
1 to 3 " ¾ in.	

For applying the Brake to a Freight Car:

35 to 45 ft. 1¼ in. Pipe.	0 or 1 Street Ell, 1¼ in.
15 " 35 " ¾ in. "	0 " 1 " " 1 in.
0 or 1 Ell, 1¼ in.	1 " 2 Ells, ¾ in.
0 " 1 " 1¼ in. x 1 in.	1 Union, ¾ in.

NOTE:—The above list applies to Clear Bottom Cars. For Hopper Bottom Cars and th unusual location of brake apparatus, a larger quantity of pipe and pipe fittings is

For applying the Compressed Air Train Signal to a Locomotive and Tender:

50 to 75 ft. ¾ in. Pipe.	1 to 3 Ells, ¼ in.
10 " 30 " ¼ in. "	2 Tees, ¾ in. x ¾ in. x
5 " 15 " ¼ in. "	1 Coupling, ¼ in.
1 Nipple ¾ in. x 4 in.	0 to 2 Unions, ¾ in.
0 to 3 Ells, ¾ in.	2 or 3 " ¼ in.
2 " ¾ in.	

For applying the Compressed Air Train Signal to a Passenger Car:

50 to 80 ft. ¾ in. Pipe.	2 or 3 Ells, ¼ in.
12 " 25 " ¼ in. "	1 Union, ¾ in.
2 Nipples, ¾ in. x 4 in.	0 or 1 " ¼ in.

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For applying the Brake to a Passenger Car:

55 to 90 ft. 1 in. Pipe.	1 or 2 Street Ells, 1 i
15 " 30 " ¾ in. "	1 Tee, 1 in. x 1 i
1 or 2 Ells, 1 in.	2 Unions, ¾ in.
1 to 3 " ¾ in.	

For applying the Brake to a Freight Car:

35 to 45 ft. 1¼ in. Pipe.	0 or 1 Street Ell, 1¼ i
15 " 35 " ¾ in. "	0 " 1 " 1 i
0 or 1 Ell, 1¼ in.	1 " 2 Ells, ¾ in.
0 " 1 " 1¼ in. x 1 in.	1 Union, ¾ in.

NOTE:—The above list applies to Clear Bottom Cars. For Hopper Bottom Cars and unusual location of brake apparatus, a larger quantity of pipe and pipe fitting

For applying the Compressed Air Train Signal to a Locomotive and Tender:

50 to 75 ft. ¾ in. Pipe.	1 to 3 Ells, ¼ in.
10 " 30 " ¼ in. "	2 Tees, ¾ in. x ¾ i
5 " 15 " ¼ in. "	1 Coupling, ¼ in
1 Nipple ¾ in. x 4 in.	0 to 2 Unions, ¾ in.
0 to 3 Ells, ¾ in.	2 or 3 " ¼ in.
1 " ¼ in.	

For applying the Compressed Air Train Signal to a Passenger Car:

50 to 80 ft. ¾ in. Pipe.	2 or 3 Ells, ¼ in.
12 " 25 " ¼ in. "	1 Union, ¾ in.
2 Nipples, ¾ in. x 4 in.	0 or 1 " ¾ in.

DESCRIPTIONS

AND INSTRUCTIONS FOR MANIPULATION

— OF —

E WESTINGHOUSE NO. 6 "ET" ENGINE AND TENDER
AKE EQUIPMENT, WITH QUESTIONS AND ANSWERS
RELATIVE TO THE PRACTICAL OPERATION
THEREOF. MODERN WESTINGHOUSE AIR
PUMPS. MODERN WESTINGHOUSE TRIPLE
VALVES. THE NEW YORK LOCOMOTIVE
BRAKE EQUIPMENT STYLE B3. THE
DUKESMITH ENGINE CONTROL
AIR BRAKE EQUIPMENT
NO. 6.

THE NO. 6 "E. T." LOCOMOTIVE BRAKE EQUIPMENT.

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IE NO. 6 "E. T." LOCOMOTIVE BRAKE EQUIPMENT.

The "E. T." Locomotive Brake equipment was introduced in and is now known as the "No. 5" E. T. Equipment. The . 6" E. T. Equipment, illustrated and described herein, is a ification of the No. 5, to accomplish the same results by ler means, as well as to embody certain additional operative ntages which railroad men suggested as valuable and desirable locomotive brake apparatus. The only difference in manipun between No. 5 and No. 6 "E. T." equipment is that on the ad engine in double heading, the No. 6 brake-valve handle re- is in *running position*, as with the old standard G-6 brake-, instead of in *lap position*, as with the No. 5 equipment.

ARRANGEMENT OF APPARATUS.

Fig. 1-A is a diagram of the No. 6 "E. T." equipment, giv- the necessary instructions for correctly piping up the equip-; Fig. 1-B is a similar diagram giving the designations of ratus and piping as referred to in the following description:

PARTS OF THE EQUIPMENT.

. THE AIR PUMP to compress the air.

. THE MAIN RESERVOIRS, in which to store and cool the air collect water and dirt.

. A DUPLEX PUMP GOVERNOR to control the pump when the sures are attained for which it is regulated.

. A DISTRIBUTING VALVE, and small double-chamber reservoir hich it is attached, placed on the locomotive to perform the tions of triple valves, auxiliary reservoirs, double check valves, -speed reducing valves, etc.

. TWO BRAKE VALVES, the AUTOMATIC to operate locomotive train brakes, and the INDEPENDENT to operate locomotive es only.

. A FEED VALVE to regulate the brake-pipe pressure.

. A REDUCING VALVE to reduce the pressure for the inde- lent brake valve and for the air-signal system when used.

. TWO DUPLEX AIR GAUGES; one, to indicate equalizing-res- ir and main-reservoir pressures; the other, to indicate brake- and locomotive brake-cylinder pressures.

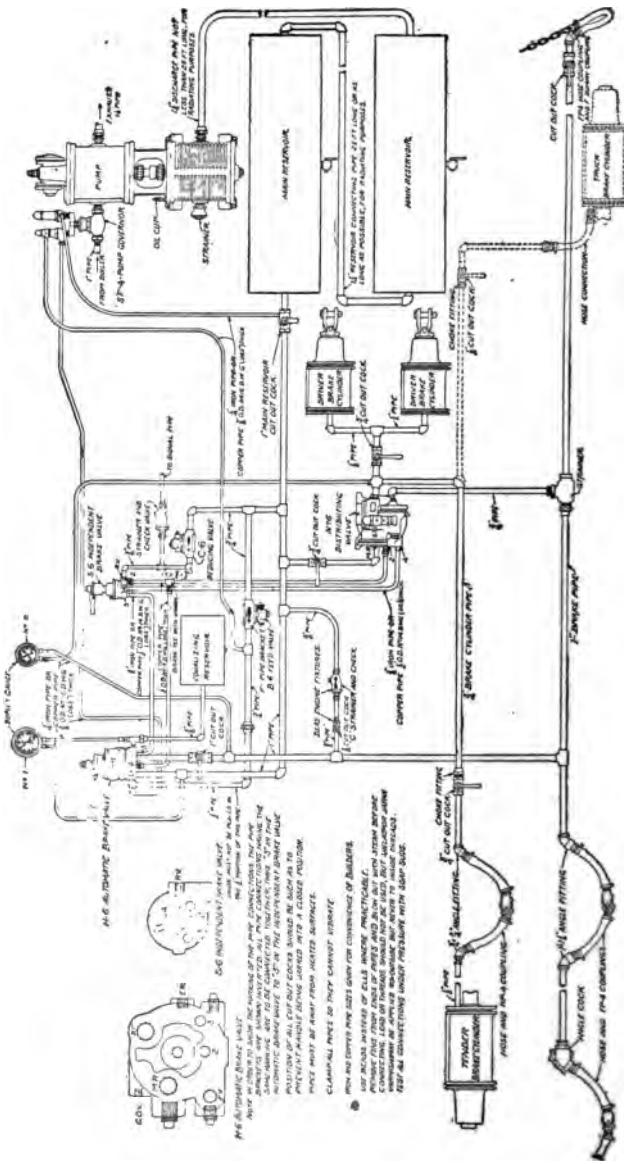


FIG. 1-A. PIPING DIAGRAM OF THE NO. 6 "E. T." EQUIPMENT.

9. DRIVER, TENDER, and TRUCK-BRAKE CYLINDERS, CUT-OUT COCKS, AIR STRAINERS, HOSE COUPLINGS, FITTINGS. etc., incidental to the piping, for purposes readily understood.

NAMES OF PIPING (Refer to Fig. 1-B).

D—DISCHARGE PIPE: Connects the Air Pump to the first Main Reservoir.

C—CONNECTING PIPE: Connects the two Main Reservoirs.

MR—MAIN-RESERVOIR PIPE: Connects the second main reservoir to the Automatic Brake Valve, Distributing Valve, Feed Valve, Reducing Valve, and Pump Governor.

FV—FEED-VALVE PIPE: Connects the Feed Valve to the Automatic Brake Valve.

E—EXCESS-PRESSURE GOVERNOR PIPE: Connects the Feed-Valve Pipe to the Excess-Pressure Head of the Pump Governor.

RV—REDUCING-VALVE PIPE: Connects the Reducing Valve to the Independent Brake Valve, and to the Signal System, when used.

BP—BRAKE PIPE: Connects the Automatic Brake Valve with the Distributing Valve and all Triple Valves on the cars in the train.

BC—BRAKE-CYLINDER PIPE: Connects the Distributing Valve with the Driver, Tender and Truck-Brake Cylinders.

H—APPLICATION-CYLINDER PIPE: Connects the Application Cylinder of the Distributing Valve to the Independent and Automatic Brake Valves.

I—DISTRIBUTING-VALVE RELEASE PIPE: Connects the Application Cylinder exhaust port of the Distributing Valve to the Automatic Brake Valve through the Independent Brake Valve.

Referring to Fig. 1-B, air compressed by the pump passes through pipes D and C as usual to the main reservoirs and the main-reservoir pipe, MR. The main-reservoir cut-out cock, W, is to cut off and vent the air from the main-reservoir pipe, when removing any of the apparatus except the governor. The end toward the main reservoir is tapped for a pipe connection, G, to the Pump Governor. Before this cock is closed the double-heading cock, X, should be closed, and the brake-valve handle placed in release position. This is to prevent the slide valve of the feed valve, and the rotary valve of the brake valve, being lifted from their seats.

Beyond the main-reservoir cut-out cock, the main-reservoir pipe has four branches, one of which runs to the automatic brake valve, one to the feed valve, one to the reducing valve, and one to the distributing valve. As a result, the automatic brake valve receives air from the main reservoirs in two ways, one direct and the other through the Feed Valve.

The Feed-Valve Pipe, FV, from the feed valve to the automatic

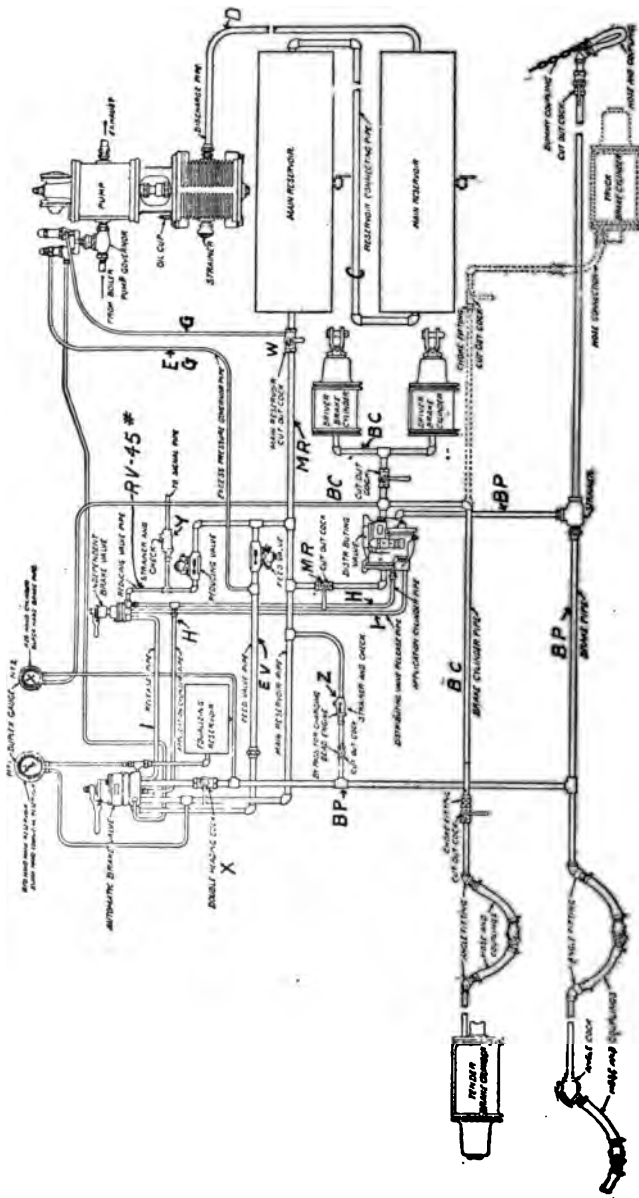


FIG. 1-B, INSTRUCTION DIAGRAM OF THE NO. 6 "E. T." EQUIPMENT.

brake valve has a branch, EG, to the top of the excess-pressure head of the duplex pump governor.

The third branch of the main-reservoir pipe connects with the reducing valve. Air at the pressure for which this valve is set (45 pounds) is supplied to the independent brake valve through the reducing-valve pipe RV. When the air-signal system is installed, it is connected to the reducing-valve pipe, in which case the reducing valve also takes the place of the signal reducing valve formerly employed. In the branch pipe supplying the air-signal system is placed a combined strainer, check-valve, and choke fitting, Y. The strainer prevents any dirt from reaching the check valve and choke fitting. The check valve prevents air from flowing back from the signal pipe when the independent brake is applied. The choke fitting prevents the reducing valve from raising the signal-pipe pressure so quickly as to destroy the operation of the signal.

LARGE DUPLEX AIR GAUGE (No. 1).

SMALL DUPLEX AIR GAUGE (No 2).

The distributing valve has five pipe connections, made through the end of the double-chamber reservoir, three on the left and two on the right. Of the three on the left, the upper, MR, is the supply from the main reservoir; the intermediate, H, is the application-cylinder pipe, leading to the independent and automatic brake valves; and the lower, I, is the distributing-valve release pipe, leading through the independent brake valve, when the handle is in running position, to the automatic brake valve. Of the two on the right, the lower, BP, is the brake-pipe-branch connection, and the upper, BC, is the brake-cylinder pipe, branching to all brake cylinders on the engine and tender. In this pipe are placed cocks for cutting out the brake cylinders when necessary, and in the engine truck and tender brake-cylinder cut-out cocks are placed choke fittings to prevent serious loss of main-reservoir air and the release

of the other locomotive brakes during a stop, in case of burst brake-cylinder hose.

The two Duplex Air Gauges are connected as follows: Gauge No. 1; Red Hand, to main-reservoir pipe under the automatic brake valve; Black Hand, to gauge-pipe tee of the automatic brake valve. Gauge No. 2; Red Hand, to the brake-cylinder pipe; Black Hand, to the brake pipe below the double-heading cock.

The amount of reduction made during an automatic application is indicated by the black hand of Gauge No. 1. The black hand of Gauge 2 is to show the brake-pipe pressure when the engine is second in double heading, or a helper.

The automatic-brake-valve connections, other than already mentioned, are the brake-pipe, the main-reservoir, the equalizing reservoir, and the lower connection to the excess-pressure head of the pump governor.

PRINCIPLES OF OPERATION.

Before taking up the description of each part of this equipment, we wish to emphasize that the principles governing the operation of it are just the same as those of previous automatic air brake equipments. The difference consists in the means for supplying the air pressure to the brake cylinders. Instead of a triple valve and auxiliary reservoir for each of the engine and tender equipments, the distributing valve is made to supply all brake cylinders. The distributing valve consists of two portions called the "equalizing portion" and "application portion." It is connected to a "double-chamber reservoir," the two chambers of which are called respectively the "pressure chamber" and the "application chamber." The latter is ordinarily connected to the application portion of the distributing valve in such a way as to enlarge the volume of that part of it called the "application cylinder" (Fig. 2). The connections between these parts as well as their operation, may be compared with that of a *miniature brake set*—the equalizing portion representing the dummy triple valve; the pressure chamber, the dummy auxiliary reservoir; and the application portion (dummy cylinders) always having practically the same pressure in its cylinder as that in the real brake cylinders. This is shown by the diagrammatic illustration in Fig. 2. For convenience, compactness and security they are combined in one device as shown in Figs. 3, 4 and 5. The equalizing portion (dummy triple) and pressure chamber (dummy auxiliary) are used in automatic applications only; reductions of brake-pipe pressure cause the equalizing valve to connect the pressure chamber dummy auxiliary to the dummy cylinder, allowing air to flow from the former to the latter. The upper slide valve connected to the piston rod of the application portion, admits air to the brake cylinders and is called the "application valve," while the lower one releases the air from the brake cylinders and is called

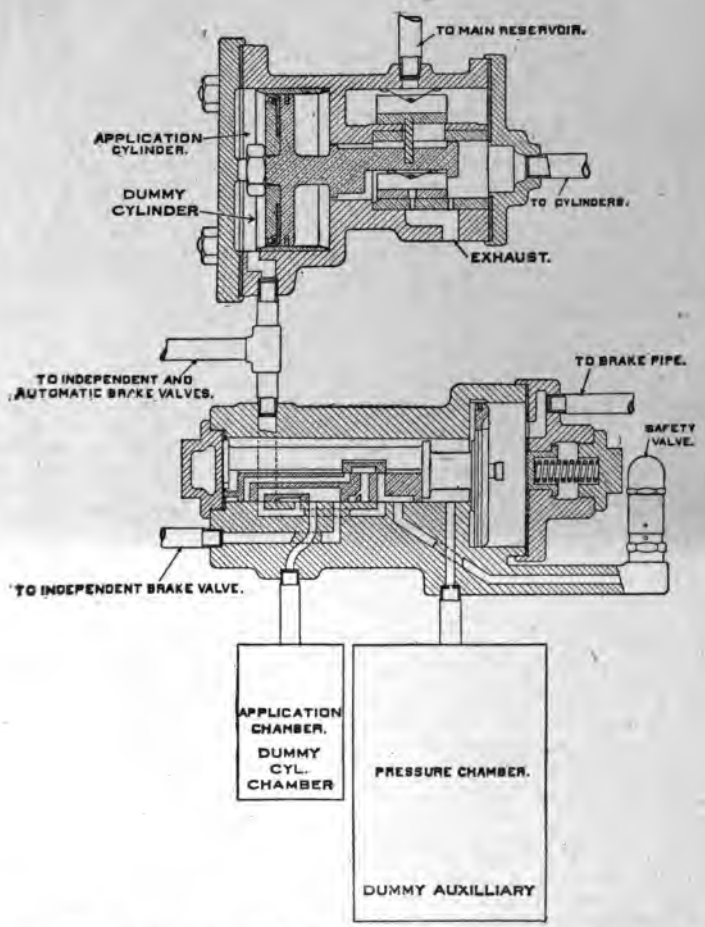


FIG. 2. DIAGRAMMATIC VIEW OF THE ESSENTIAL PARTS OF THE DISTRIBUTING VALVE, AND DOUBLE-CHAMBER RESERVOIR.

the "exhaust valve." As the air admitted to the brake cylinders comes directly from the main reservoirs, the supply is practically unlimited. Any pressure in the dummy cylinder will force the application piston to close the exhaust valve, open the application valve and admit air from the main-reservoirs to the locomotive brake cylinders until their pressure equals that in the dummy cylinder; any variation of this (dummy) cylinder pressure will be exactly duplicated in the locomotive brake cylinders, and the resulting pressure maintained regardless of any brake-cylinder leakage. The whole operation of this locomotive brake, therefore, consists in admitting and releasing air pressure into or out of the dummy cylinder, in independent applications directly through the independent brake valve; in automatic applications, by means of the equalizing (dummy triple valve) portion and the air pressure stored in the pressure chamber (dummy auxiliary).

The well known principle embodied in the quick-action triple valve, by which it gives a high braking power in emergency applications, and a sufficiently lower one in full service applications, to provide a desired protection against wheel sliding, is embodied in the No. 6 distributing valve. This is accomplished by cutting off the application chamber from the application cylinder in all emergency applications. In such applications, the pressure chamber has to fill the small volume of the application cylinder only, thus giving a high equalization, and a correspondingly high brake-cylinder pressure. In service applications, it must fill the same volume combined with that of the application chamber, thus giving a lower equalization and correspondingly lower brake-cylinder pressure.

The following description gives the operation in detail.

THE NO. 6 DISTRIBUTING VALVE.

This valve is the important feature of the "E. T." equipment. Fig. 3 shows photographic views of the valve and its double-chamber reservoir. The pipe connections, as previously referred to, are plainly shown. Fig. 4 shows the two chambers of the reservoir. The safety valve, 34, is an essential part of the distributing valve, and is described under the heading "E-6 Safety Valve."

Referring to Figs. 4 and 5, the names of parts of this apparatus are as follows: 2, Body; 3, Application-Valve Cover; 4, Cover Screw; 5, Application Valve; 6, Application-Valve Spring; 7, Application-Cylinder Cover; 8, Cylinder-Cover Bolt and Nut; 9, Cylinder-Cover Gasket; 10, Application Piston; 11, Piston Follower; 12, Packing-Leather Expander; 13, Packing Leather; 14, Application-Piston Nut; 15, Application-Piston Packing Ring; 16, Exhaust Valve; 17, Exhaust-Valve Spring; 18, Application-Valve Pin; 19, Application-Piston Graduating Stem; 20, Application-Piston Graduating Spring; 21, Graduating-Stem Nut; 22, Upper

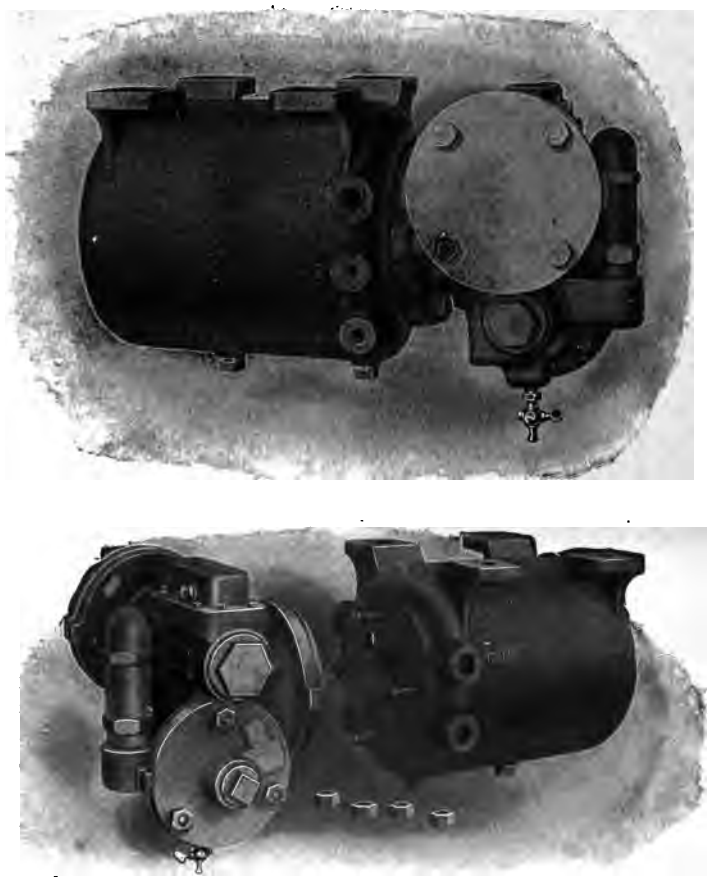


FIG. 3. NO. 6 DISTRIBUTING VALVE AND DOUBLE CHAMBER RESERVOIR.

Connections: MR—Main-Reservoir Pipe; 1—Distributing-Valve Release Pipe; 2—Application-Cylinder Pipe; CYLS—Brake-Cylinder Pipe; BP—Brake Pipe.

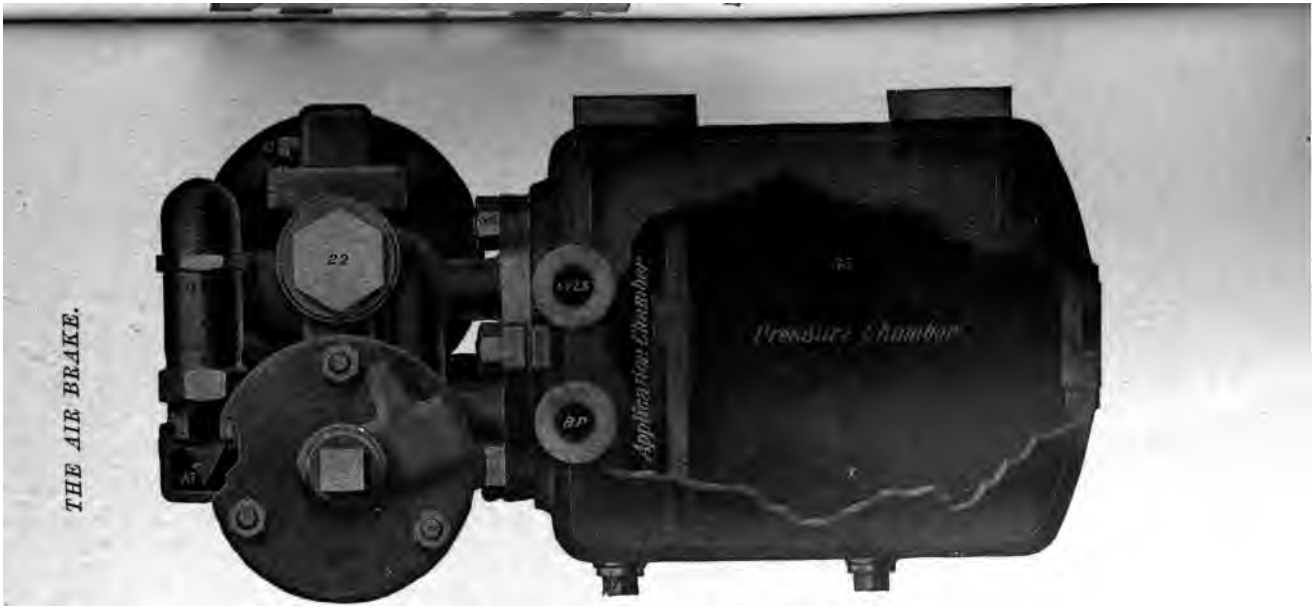


FIG. 4. NO. 6 DISTRIBUTING VALVE AND DOUBLE-CHAMBER RESERVOIR.

Pipe Connections: CYLS—Brake-Cylinders Pipe; BP—Brake Pipe.

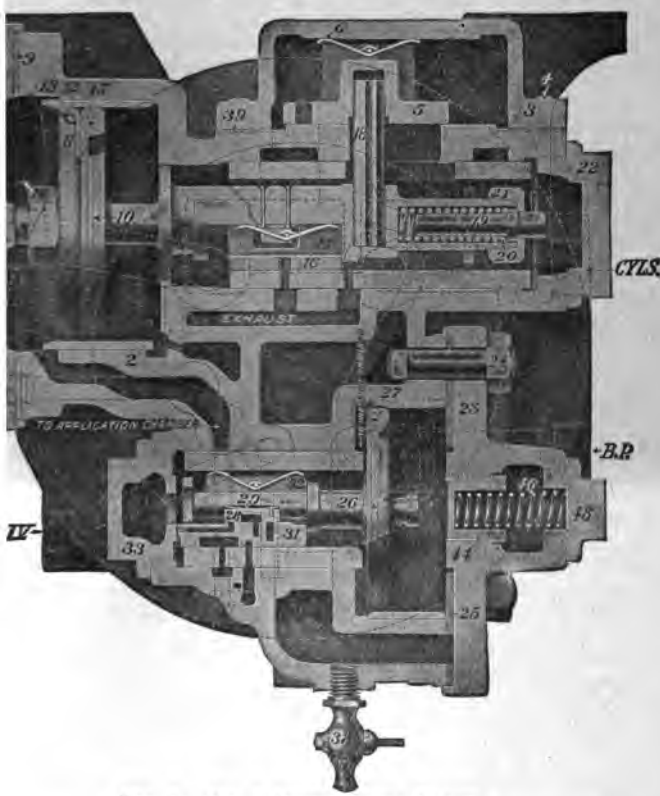


FIG. 5. NO. 6 DISTRIBUTING VALVE.

ctions: MR—Main-Reservoir Pipe; IV—Distributing-Valve elease Pipe; II—Application-Cylinder Pipe; CYLS—Brake-ylinder Pipe; BP—Brake Pipe.

Cap Nut; 23, Equalizing-Cylinder Cap; 24, Cylinder-Cap Bolt and Nut; 25, Cylinder-Cap Gasket; 26, Equalizing Piston; 27, Equalizing-Piston Packing Ring; 28, Graduating Valve; 29, Graduating-Valve Spring; 31, Equalizing Valve; 32, Equalizing-Valve Spring; 33, Lower Cap Nut; 34, Safety Valve; 35, Double-Chamber Reservoir; 36, Reservoir Stud and Nut; 37, Reservoir Drain Plug; 38, Distributing-Valve Drain Cock; 39, Application-Valve-Cover Gasket; 40, Application-Piston Cotter; 41, Distributing-Valve Gasket (not shown); 42, Oil Plug; 43, Safety-Valve Air Strainer; 44, Equalizing-Piston Graduating Sleeve; 45, Equalizing-Piston Graduating-Spring Nut; 46, Equalizing-Piston Graduating Spring.

To simplify the tracing of the ports and connections, the various positions of this valve are illustrated in nine diagrammatic views; that is, the valve is distorted to show the parts differently than actually constructed with the object of explaining the operation clearly instead of showing exactly how they are designed. The chambers of the reservoir are for convenience indicated at the bottom as a portion of the valve itself. In Fig. 5, equalizing piston 26, graduating valve 28, and equalizing slide valve 31, are shown as actually constructed. But as there are ports in the valves which cannot thus be clearly indicated, the diagrammatic illustrations show each slide valve considerably elongated so as to make all the ports appear in one plane, with similar treatment of the equalizing-valve seat. Fig. 6 shows the correct location of these ports.

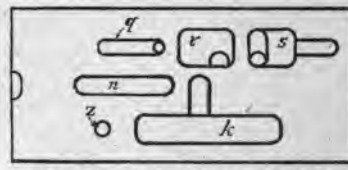
Referring to Fig. 7 it will be seen that main-reservoir pressure is always present in the chamber surrounding application valve 5 by its connection through passage *a*, *a*, to the main-reservoir pipe. Chamber *b* to the right of application piston 10 are always in free communication with the brake cylinders, through passage *c* and the brake-cylinder pipe. Application cylinder *g* at the left of application piston 10 is connected by passage *h* with the equalizing valve seat, and to the brake valves through the application-cylinder pipe.

AUTOMATIC OPERATION.

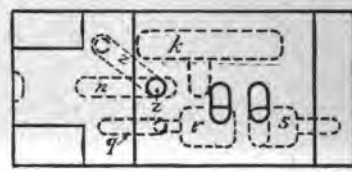
Charging. Referring to Fig. 7, which shows the movable parts of the valve in the release position, it will be seen that as chamber *p* is connected to the brake pipe, brake-pipe air flows through the feed groove *v* around the top of piston 26 into the chamber above equalizing valve 31, and through port *o* to the pressure chamber, until the pressures on both sides of the piston are equal.

Service. When a service application is made with the automatic brake valve, the brake-pipe pressure in chamber *p* is reduced, causing a difference in pressure on the two sides of this piston, which results in the piston moving toward the right. The first movement of the piston closes the feed groove, and at the same time moves the graduating valve until it uncovers the upper

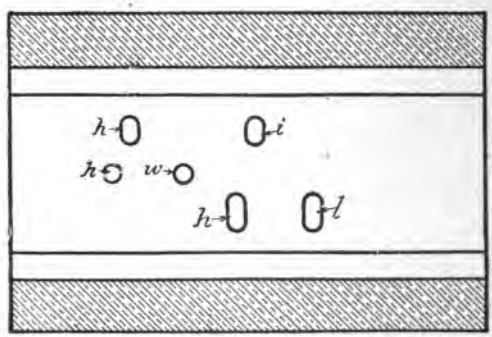
PLAN OF
GRADUATING VALVE.



FACE OF SLIDE VALVE.



PLAN OF SLIDE VALVE.



PLAN OF SLIDE VALVE SEAT.

IG. 6. GRADUATING VALVE, EQUALIZING VALVE, AND EQUALIZING VALVE SEAT OF NO. 6 DISTRIBUTING VALVE.

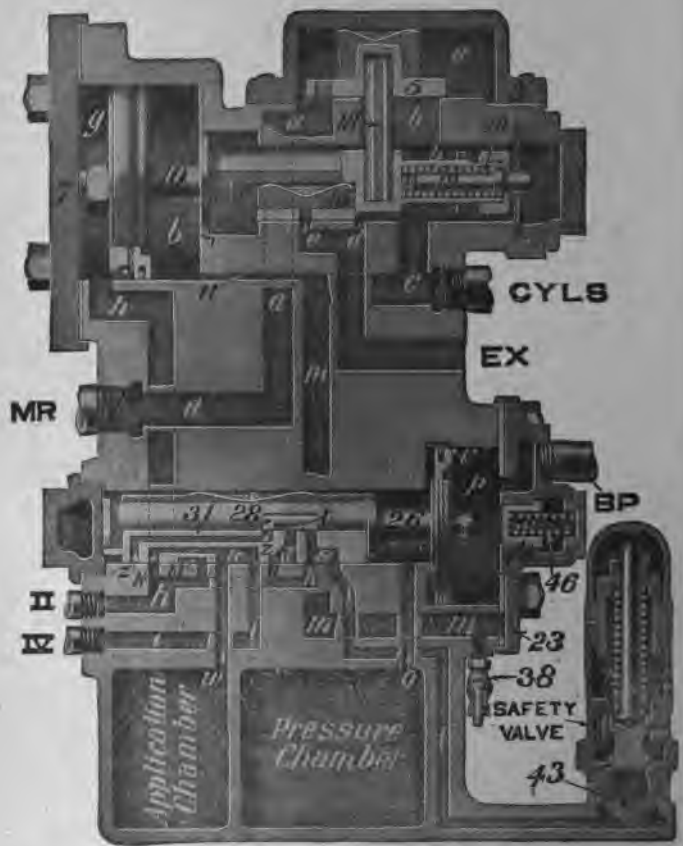
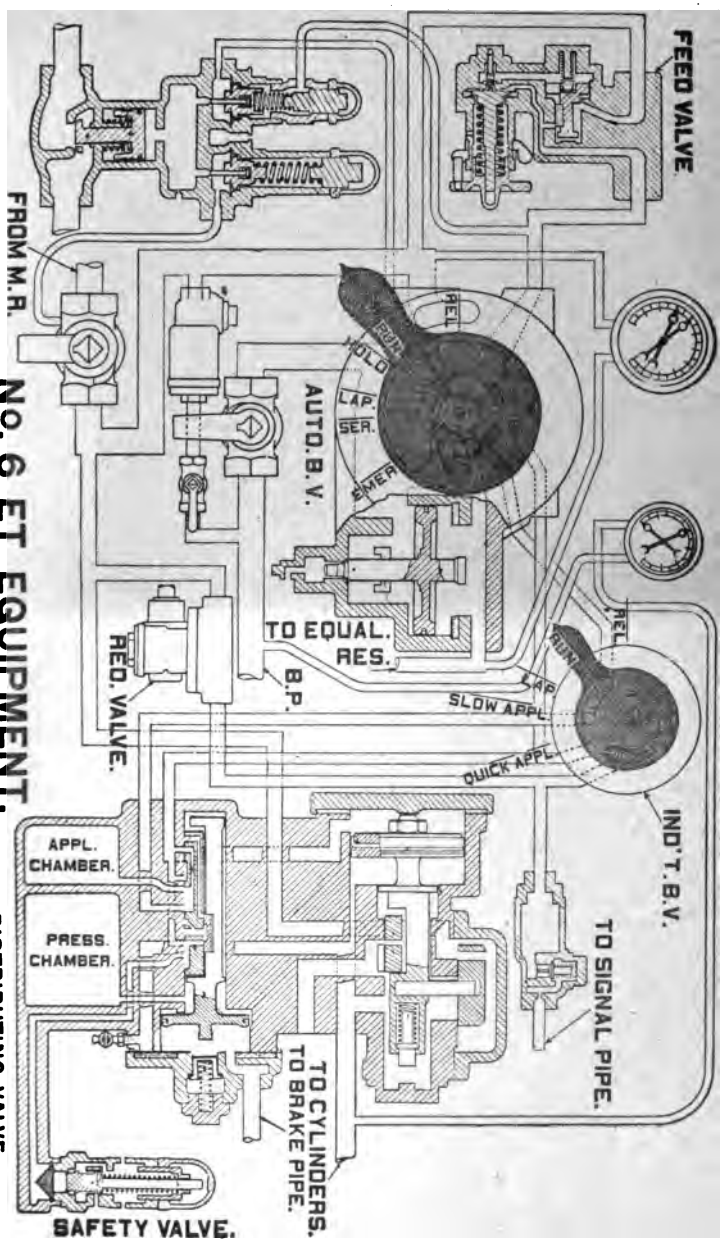


FIG. 7. RELEASE, AUTOMATIC OR INDEPENDENT.

Connections: MR—Main-Reservoir Pipe; IV—Distributing-Valve Release Pipe; II—Application-Cylinder Pipe; CYLS—Brake-Cylinder Pipe; BP—Brake Pipe.



No. 6 ET EQUIPMENT.

DISTRIBUTING VALVE.

end of port *z* in the equalizing valve 31. As the piston continues its movement, the shoulder on the end of its stem engages the equalizing valve, which is then also moved to the right until the piston strikes equalizing-piston graduating sleeve 44, graduating spring 46 preventing further movement; port *z* in the equalizing valve then registers with port *h* in the seat, and cavity *n* in the equalizing valve connects ports *h* and *w* in the seat. As the equalizing-valve chamber is always in communication with the pressure chamber, air can now flow from the latter to both the application cylinder and application chamber. This pressure forces application piston 10 to the right, as shown in Fig. 8, causing exhaust valve 16 to close exhaust ports *e* and *d*, and to compress application-piston graduating spring 20; also causing application valve 5, by its connection with the piston stem through pin 18, to open its port and allow air from the main-reservoirs to flow into chambers *b*, *b* and through passage *c* to the brake cylinders.

During the movement just described, cavity *t* in the graduating valve connects ports *r* and *s* in the equalizing valve, and by the same movement ports *r* and *s* are brought into register with ports *h* and *l* in the seat, thus establishing a communication from the application cylinder to the safety-valve, which being set at 68 pounds, limits the brake-cylinder pressure to this amount, which is 3 pounds above the maximum obtained in emergency application from original 70 pounds.

The amount of pressure resulting in the application cylinder for a certain brake-pipe service reduction, depends on the comparative volumes of the pressure chamber, application cylinder and its chamber. These volumes are such that with 70 pounds in the pressure chamber and nothing in the application cylinder and chamber, if they are allowed to equalize, for an example, as with a 20-pound brake pipe reduction, they will show about 50 pounds.

Service Lap. When the brake-pipe reduction is not sufficient to cause a full service application, the conditions described above continue until the pressure in the pressure chamber is reduced enough below that in the brake pipe to cause piston 26 to force graduating valve 28 to the left until stopped by the shoulder on the piston stem striking the right-hand end of equalizing valve 31, the position indicated in Fig. 9, and shown as SERVICE LAP. In this position, graduating valve 28 has closed port *s* so that no more air can flow from the pressure chamber to the application cylinder and chamber. It also has closed port *s*, cutting off communication to the safety valve, so that any possible leak in the latter cannot reduce the application-cylinder pressure, and thus similarly affect the pressure in the brake cylinders. The flow of air past application valve 5 to the brake cylinders continues until their pressure slightly exceeds that in the application cylinder when the higher pressure and application-piston graduating spring together force piston 10 to the left to the position shown in Fig. 9, thereby closing port *b*. Further movement is prevented by the

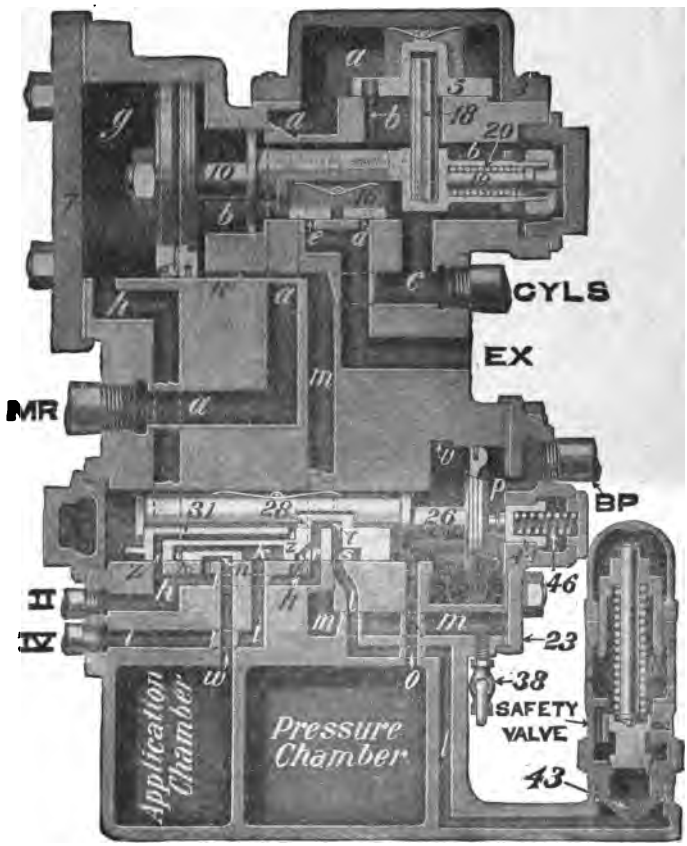
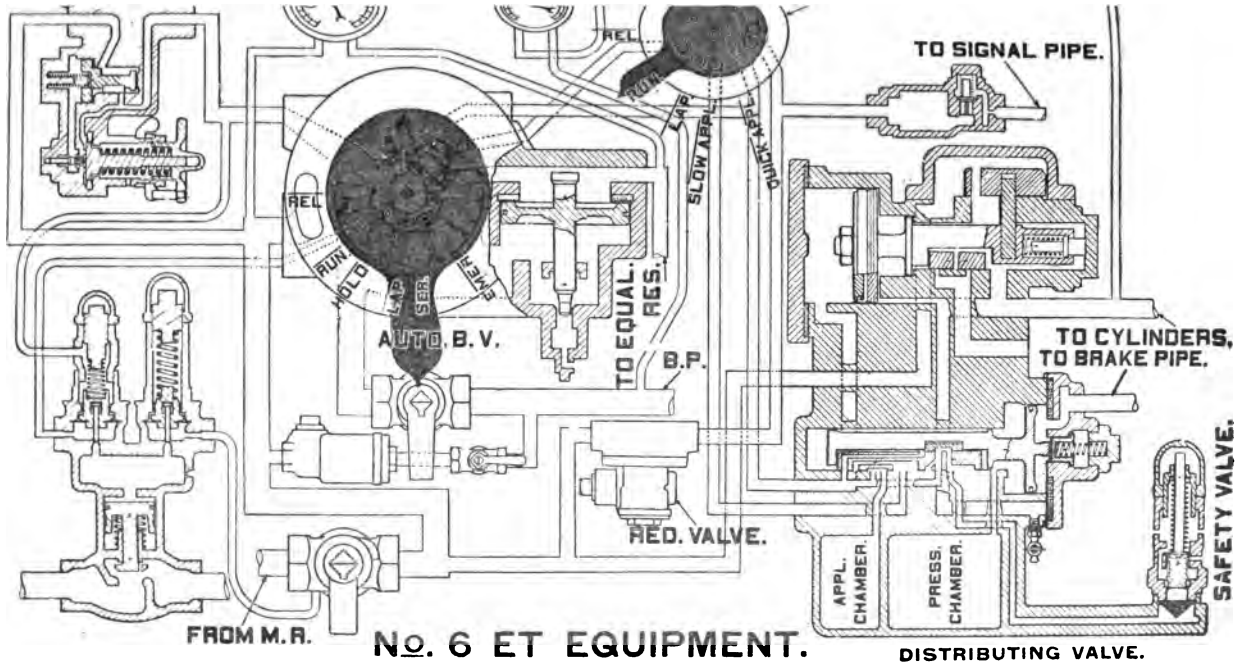


FIG. 8. AUTOMATIC SERVICE.



No. 6 ET EQUIPMENT.

AUTOMATIC SERVICE POSITION

esistance of exhaust valve 16, and the application-piston grad-ating spring having expanded to its normal position, The brake-ylinder pressure is then practically the same as that in the appli-ation cylinder and chamber.

From the above description it will be seen that application pis-on 10 has application-cylinder pressure on one side and brake-ylinder pressure on the other. When either pressure varies, the iston will move toward the lower. Consequently if that in cham-er *b* is reduced, by brake-cylinder leakage, the pressure main-ained in the application cylinder will force piston 10 to the right, pening application valve 5 and again admitting air from the nain-reservoirs to the brake cylinders until the pressure in cham-er *b* is again slightly above that in the application cylinder when he piston again moves back to lap position. In this way the rake-cylinder pressure is always maintained equal with that in he application cylinder. This is the *pressure-maintaining* feat-re.

Automatic Release. When the automatic brake valve is placed in release-position, and the brake-pipe pressure in chamber *p* is thereby increased above that in the pressure chamber, equalizing piston 26 moves to the left, carrying with it equalizing valve 31 and graduating valve 28 to the position shown in Fig. 7. The feed grove *v* now being open permits the pressure in the pressure hamber to feed up until it is equal with that in the brake pipe as efore described. This action does not release the locomotive rakes because it does not discharge application-cylinder pressure. The release pipe is closed by the rotary valve of the automatic rake valve, and the application-cylinder pipe is closed by the otary valves of both brake valves. To release the locomotive rakes, the automatic brake valve must be moved to running posi-ion. The release pipe is then connected by the rotary valve to he atmosphere, and as exhaust cavity *k* in the equalizing valve 1 connects ports *i*, *w* and *h* in the valve seat, application-cylin-ler and chamber pressure will escape. As this pressure reduces, he brake-cylinder pressure will force application piston 10 to he left until exhaust valve 16 uncovers exhaust ports *d* and *e*, llowing brake-cylinder pressure to escape (See Fig. 7), or in ase of graduated release, to reduce in like amount to the reduc-ion in the application-cylinder pressure.

Emergency. When a sudden and heavy brake-pipe reduction s made, as in an emergency application, the air in the pressure hamber forces equalizing piston 26 to the right with sufficient orce to compress equalizing-piston graduating spring 46, so that he piston moves until it strikes against the leather gasket eneath cap 23 as shown in Fig. 10. This movement causes qualizing valve 31 to uncover port *h* in the bush without opening ort *w*, making a direct opening from the pressure chamber to he *application cylinder only*, so that they quickly become equal-

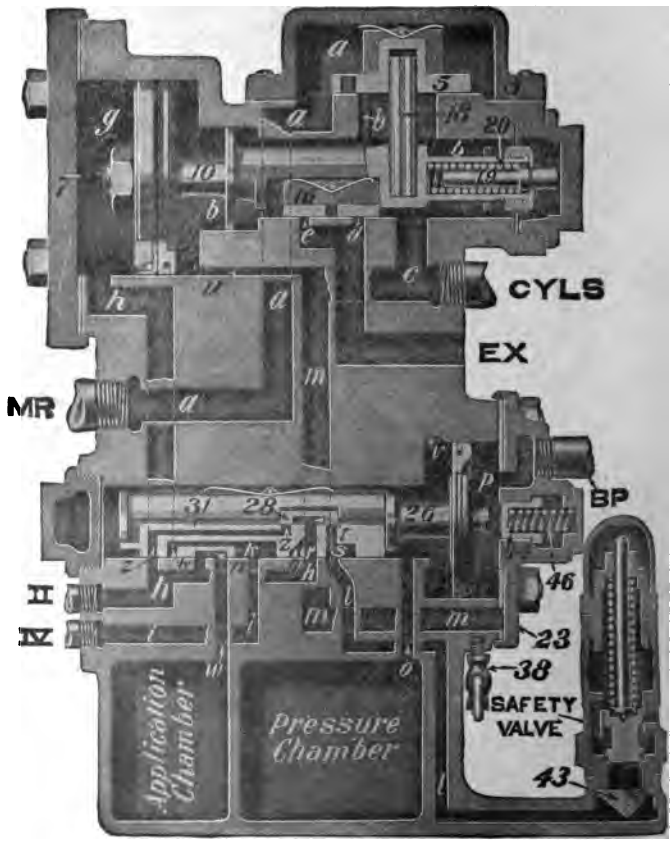
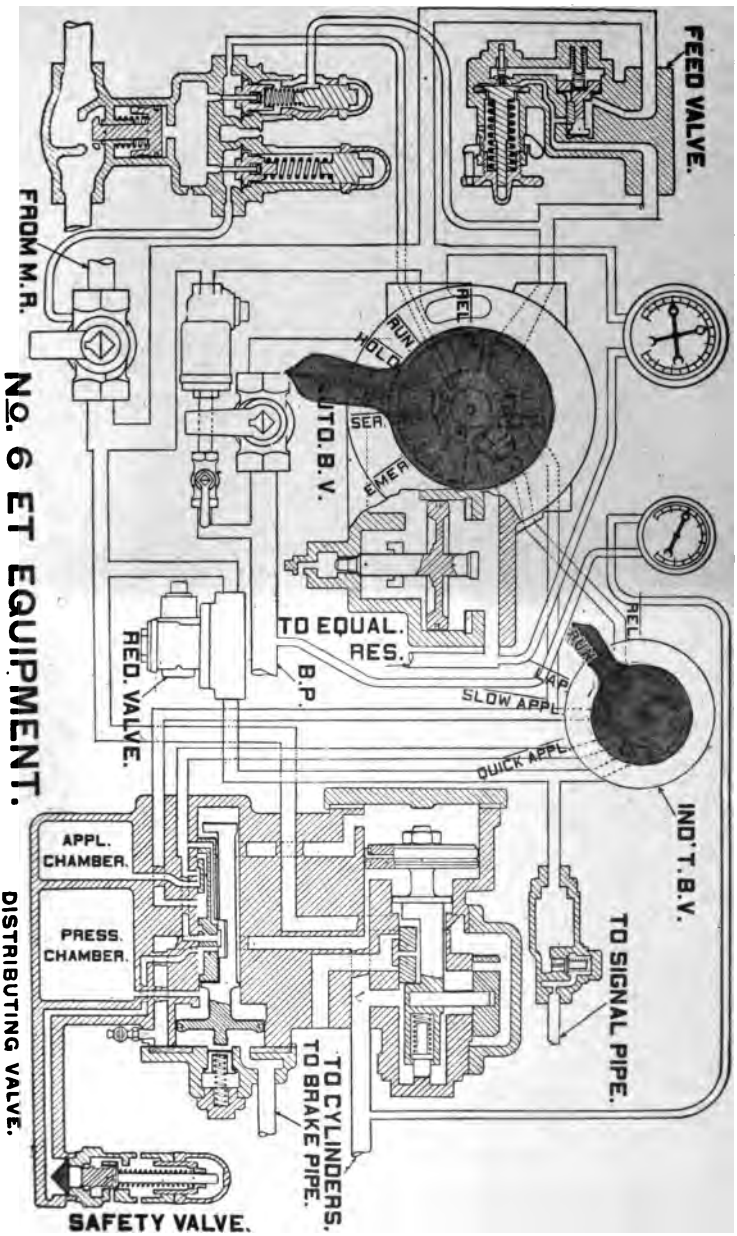


FIG. 9. SERVICE LAP.



No. 6 ET EQUIPMENT.

ized. This cylinder volume, being small, and connected with that of the pressure chamber at 70-pounds pressure, equalizes at about 65 pounds. Also in this position of the automatic brake valve, a small port in the rotary valve allows air from the main-reservoirs to feed into the application-cylinder pipe, and thus to the application cylinder. The application cylinder is now connected to the safety valve through port *h* in the seat, cavity *q* and port *r* in the equalizing valve, and port *s* in the seat. Cavity *q* and port *r* in the equalizing valve are connected by a small port, the size of which permits the air in the application cylinder to escape through the safety valve at the same rate that the air from the main-reservoirs, feeding through the rotary valve of the automatic brake valve, can supply it, preventing the pressure from rising above the adjustment of the safety valve.

In High-Speed Brake Service, the feed valve is regulated for 110-pounds brake-pipe pressure instead of 70, and main-reservoir pressure is 130 or 140 pounds. Under these conditions an emergency application raises the application-cylinder pressure to about 93 pounds, but the passage between cavity *q* and port *r* is so small that the flow of application-cylinder pressure to the safety valve is just enough greater than the supply through the brake valve, to decrease that pressure in practically the same time and manner as is done by the high-speed reducing valve, until it is approximately 75 pounds. The reason why the pressure in the application cylinder, pressure chamber and brake cylinders does not fall to 68 pounds, to which pressure the safety-valve is adjusted, is because the inflow of air through the brake valve with the high main-reservoir pressure used in high-speed service is equal, at 75 pounds, to the outflow through the small opening to the safety valve. This is done to get a shorter stop in emergency. The application portion of the distributing valve operates similarly, but more quickly than in service application.

Emergency Lap. The movable parts of the valve remain in the position shown in Fig. 10 until the brake-cylinder pressure slightly exceeds the application-cylinder pressure, when the application piston and application valve move back to the position known as *Emergency Lap* as shown in Fig. 11.

The release after an emergency is brought about by the same manipulation of the automatic brake valve as that following service application, but the effect on the distributing valve is somewhat different. When the equalizing piston, valve, and graduating valve are forced to the release position by the increased brake-pipe pressure in chamber *p*, the application chamber, with no pressure in, is connected to the application cylinder, with the emergency pressure in, through port *w*, cavity *k*, and port *h*. The pressure in the application cylinder at once expands into the application chamber until these pressures are equal, which results in the release of brake-cylinder pressure until it is slightly less than that in application cylinder and

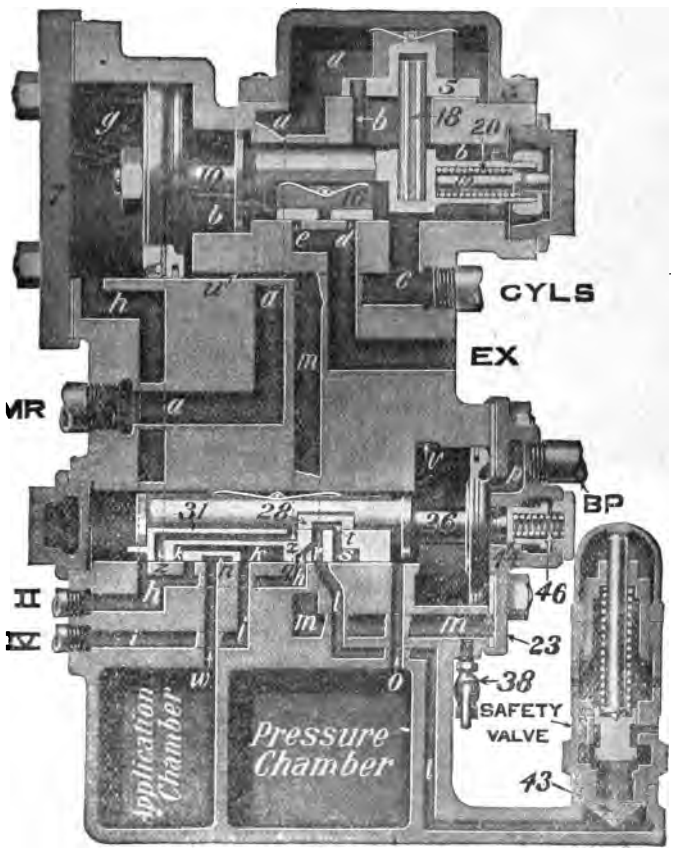
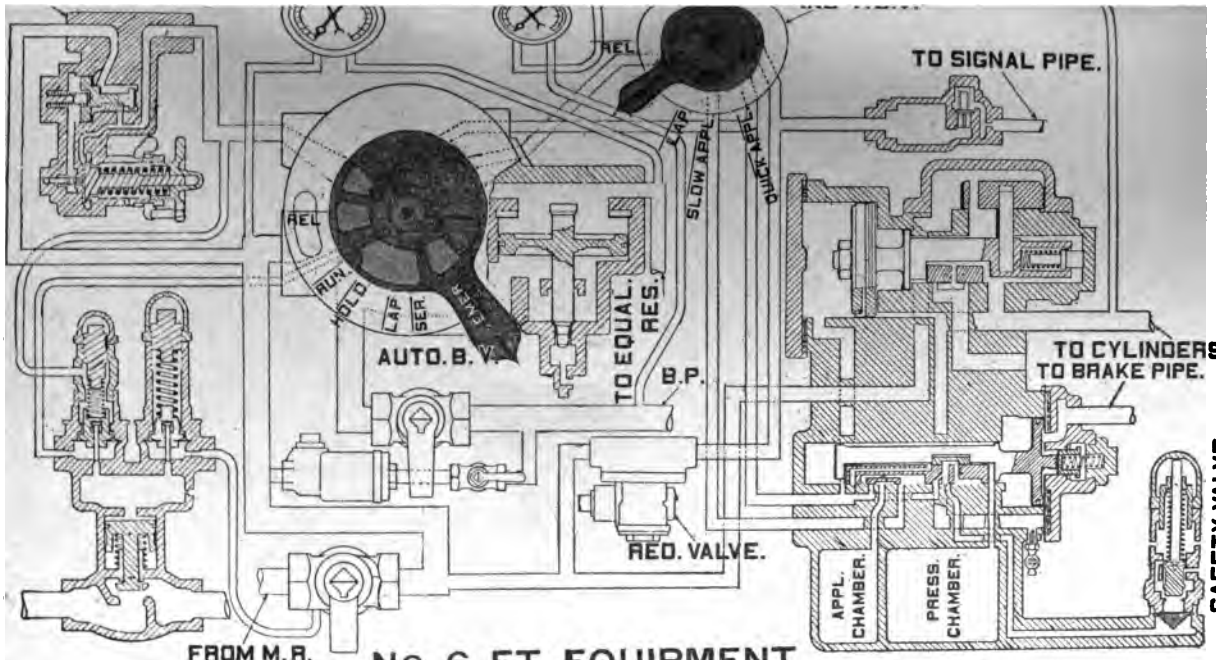


FIG. 10. EMERGENCY.



EMERGENCY POSITION

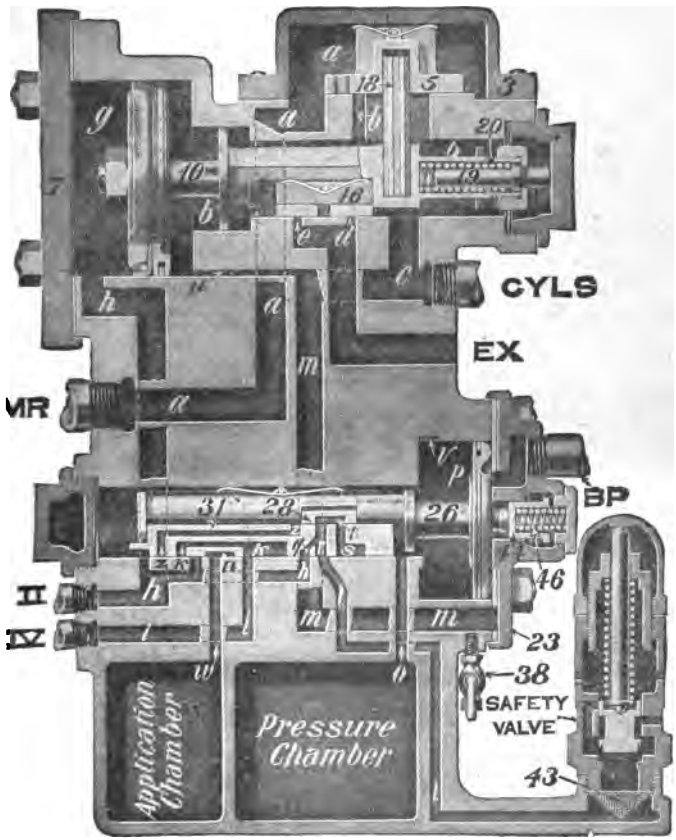
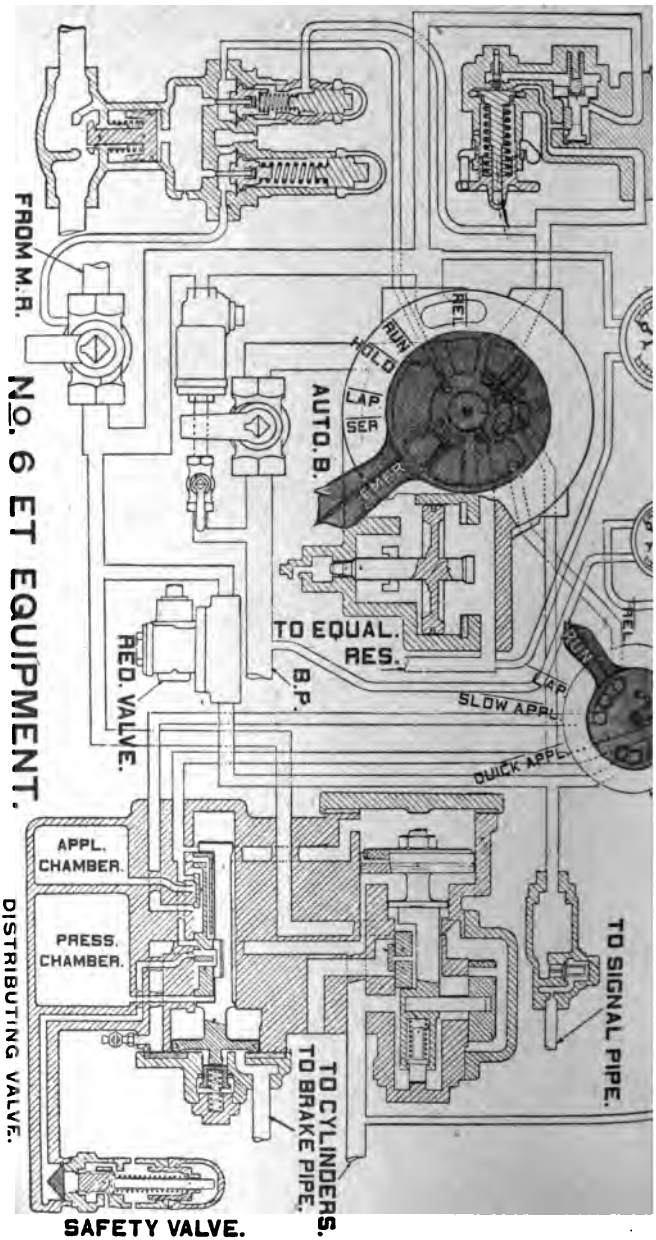


FIG. 11. EMERGENCY LAP.



EMERGENCY LAP POSITION

chamber. Consequently, in releasing after an emergency, the brake-cylinder pressure will *automatically* reduce to about 15 pounds, which will remain until the automatic-brake-valve handle is moved to running position.

If the brakes are applied by a conductor's valve, a burst hose, or parting of train, the movement of equalizing valve 31 breaks the connection between ports *h* and *i* through cavity *k*, so that the brakes will apply and remain applied until the brake-pipe pressure is restored. The handle of the automatic brake valve should be moved to lap position to prevent a loss of main-reservoir pressure.

INDEPENDENT BRAKE OPERATION.

Independent Application. When the handle of the Independent Brake Valve is moved to either application position, air from the main reservoir, limited by the reducing valve to a maximum of 45 pounds, is allowed to flow to the application cylinder, forcing application piston 10 to the right as shown in Fig. 12. This movement causes application valve 5 to open its port and allow air from the main-reservoirs to flow into chambers *b*, *b* and through passage *c* to the brake cylinders, as in an automatic application, until the pressure slightly exceeds that in the application-cylinder. The application-piston graduating spring and higher pressure then force application piston 10 to the left until application valve 5 closes its port. Further movement is prevented by the resistance of exhaust valve 16, and the application-piston graduating spring having expanded to its normal position. This position, shown in Fig. 13, is known as *Independent Lap.*

It will be seen that whatever pressure exists in the application cylinder will be maintained in the brake cylinders by the "pressure maintaining" feature already described under the heading "SERVICE LAP," and indicated in Fig. 9.

Independent Release. When the handle of the independent brake valve is moved to release position, a direct opening is made from the application cylinder to the atmosphere. As the application-cylinder pressure escapes, brake-cylinder pressure in chambers *b* moves application piston 10 to the left, causing exhaust valve 16 to open exhaust ports *e* and *d* as shown in Fig. 7, thereby allowing brake-cylinder pressure to discharge to the atmosphere.

If the independent brake valve is returned to lap before all of the application-cylinder pressure has escaped, the application piston 10 will return to *independent lap* position as soon as the brake-cylinder pressure is reduced a little below that remaining in the application cylinder, thus closing exhaust ports *e* and *d*, and holding the remaining pressure in the brake cylinders. In this way the independent release may be graduated as desired.

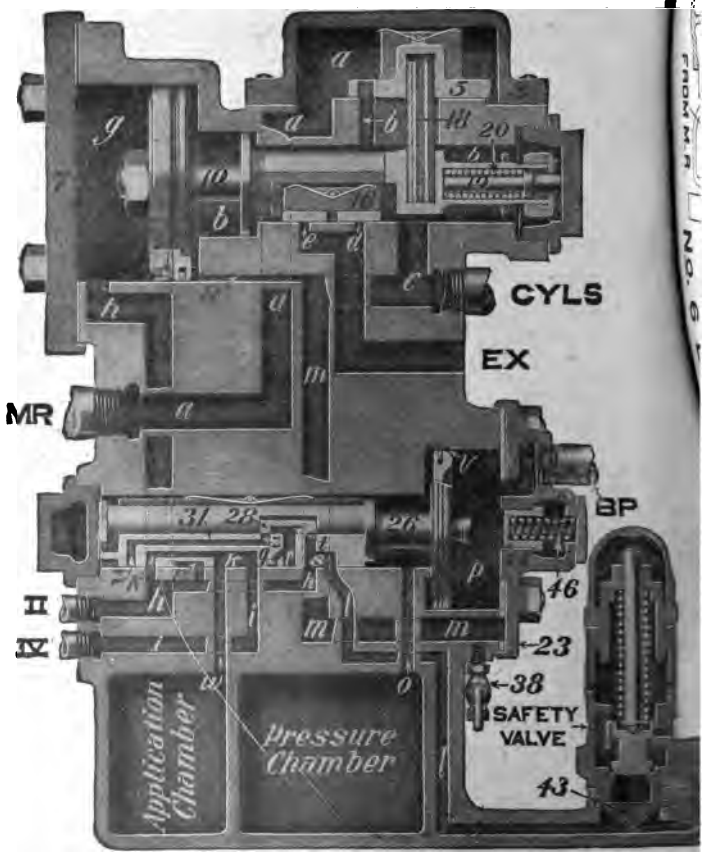
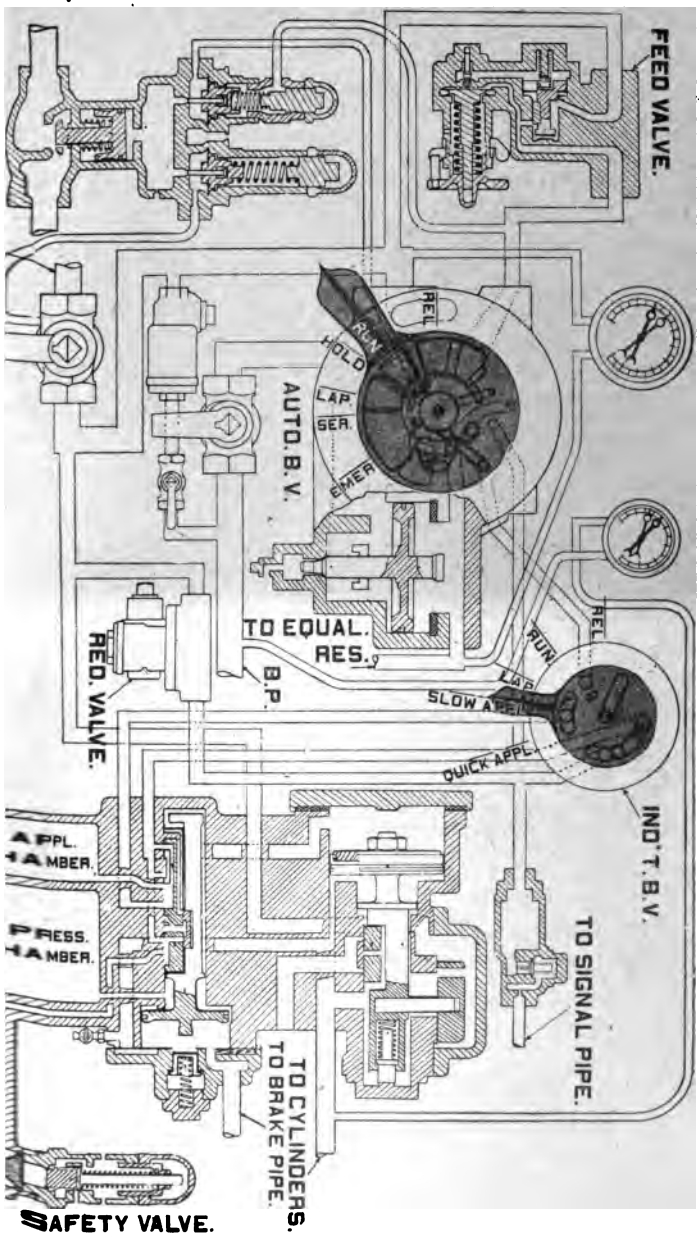


FIG. 12. INDEPENDENT APPLICATION.


FEED VALVE.
REL.
RUN
HOLD
LAP
SER.
EMER
AUTO. B. V.
TO EQUAL. RES.
B.P.
RED. VALVE.
REL.
RUN
LAP
SLOW APPL.
QUICK APPL.
IND'T. B.V.
TO SIGNAL PIPE.
TO CYLINDERS.
TO BRAKE PIPE.
SAFETY VALVE.

This equipment has all the flexibility and ease of manipulation possessed by the combined automatic and straight air equipment, with much less apparatus and complication, besides the other important features of pressure maintaining, equal pressures in all brake cylinders, and the fact that it is *always* possible to release the locomotive brakes with the independent-brake valve, even when automatically applied. In connection with this last mentioned feature, Fig. 14 shows the position the distributing-valve parts will assume, if the locomotive brakes are released by the independent brake valve after an automatic application has been made. This results in the application portion going to release position without changing the conditions in either the pressure-chamber or brake pipe; consequently, the equalizing portion does not move until release is made by the automatic brake valve.

An independent release of locomotive brakes may also be made in the same manner, after an emergency application by the automatic brake valve. However, owing to the fact that, in this position, the automatic brake valve will be supplying the application cylinder through the maintaining port in the rotary valve, the handle of the independent brake valve must be *held* in release position to prevent the locomotive brakes from reapplying, so long as the handle of the automatic brake valve remains in emergency position. The equalizing portion of the distributing valve will remain in the position shown in Figs. 10 and 11, while the application portion will assume the position shown in Fig. 14.

Double Heading. When there are two or more locomotives in a train, the handles of both brake valves on each locomotive except the one from which the brakes are being operated, should be carried in *running* position. The release pipe is then open to the atmosphere at the automatic brake valve, and the operation of the distributing valve is the same as that described during automatic-brake applications. In double heading, therefore, the application and the release of the distributing valve on each helper locomotive is similar to that of the triple valves on the train. But in case an engineer on a helper finds it necessary to apply or to release his brakes independently of the train, he can do so by using the independent brake valve, without moving the handle of the automatic valve.

Port *u* drains the application cylinder of any moisture precipitated from the air in chambers *b*; such moisture passes to the lower part of the distributing valve through port *m*, where it may be drawn off by drain cock 38.

To remove piston 10 and slide valve 16, it is absolutely necessary to *first* remove cover 3, application valve 5 and valve pin 18.

THE QUICK-ACTION CYLINDER CAP.

The equalizing portion of the distributing valve, as already

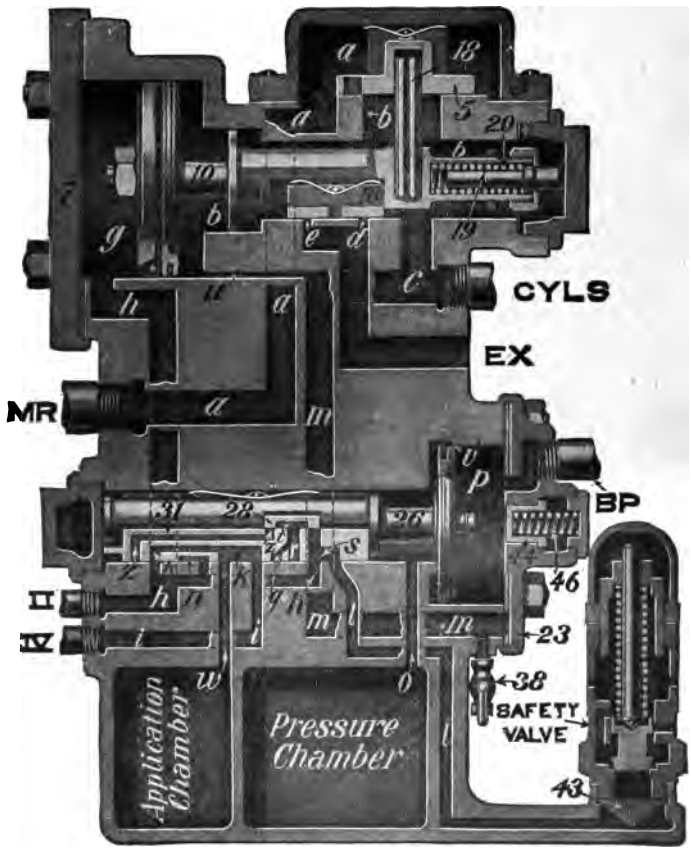
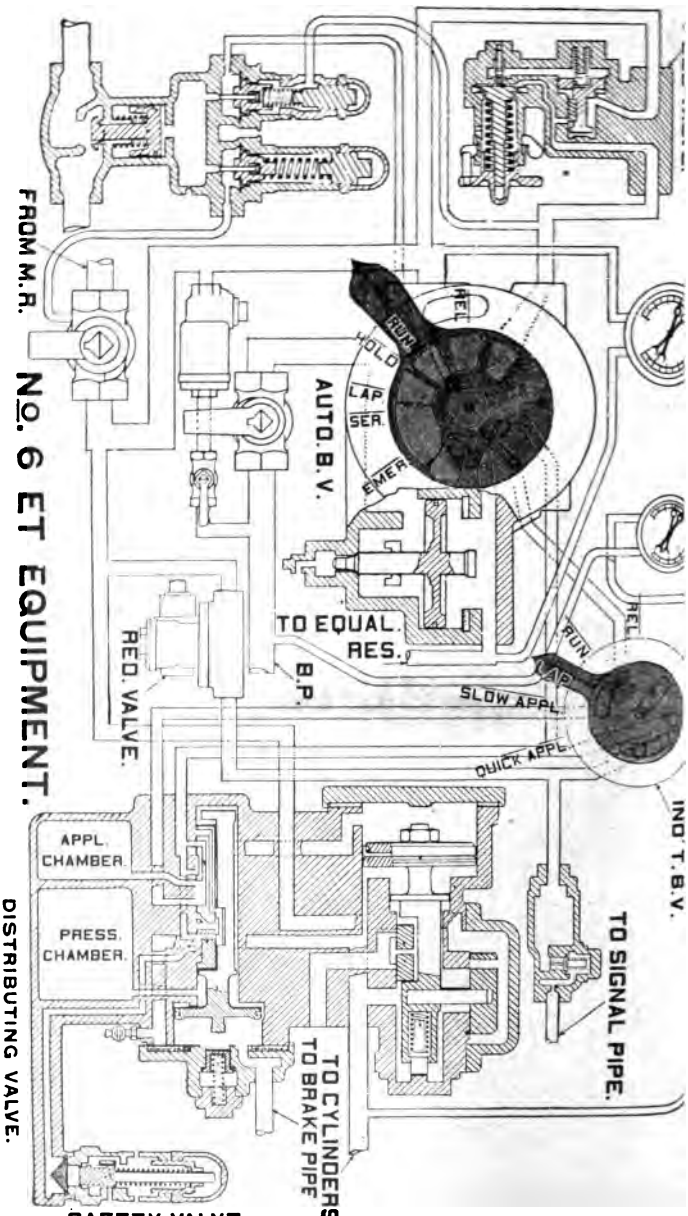


FIG. 13. INDEPENDENT LAP.



INDEPENDENT LAP POSITION

described, corresponds to the plain triple valve of the old standard locomotive brake equipments. There are, however, conditions under which it is advisable to have it correspond to a quick-action triple; that is,—vent brake-pipe air into the brake cylinders in an emergency application. To obtain this, the cylinder cap 23, Fig. 5, is replaced by the "Quick-Action Cylinder Cap," illustrated in Fig. 15.

In an emergency application, as equalizing piston 26 moves to the right and seals against the gasket (Fig. 16) the knob on the piston strikes the graduating stem 50, causing it to compress equalizing-piston graduating spring 55, and move slide valve 48 to the right, opening port *j*. Brake-pipe pressure in chamber *p* flows to chamber X, pushes down check valve 53, and passes to the brake cylinders through port *m* in the cap and distributing-valve body. When the brake cylinders and brake pipe equalize, check valve 53 is forced to its seat by spring 54, thus preventing air in the brake-cylinders from flowing back into the brake pipe. When a release of the brakes occurs and piston 26 is moved back to its normal position (Fig. 7), spring 55 forces graduating stem 50 and slide-valve 48 back to the position shown in Fig. 15.

In all other respects, the operation of a distributing valve having this cap is exactly as described before.

E-6 SAFETY VALVE.

Fig. 17 is a sectional view of the safety valve which is an essential part of the distributing valve. It is unlike the ordinary safety valve, as its construction is such as to cause it to close quickly with a "pop" action, insuring its seating firmly. It is sensitive in operation and responds to slight differences of pressure.

The names of the parts are 2, Body; 3, Cap Nut; 4, Valve; 5, Valve Stem; 6, Adjusting Spring; 7, Adjusting Nut.

Valve 4 is held to its seat by the compression of spring 6 between the stem and adjusting nut 7. When the pressure below valve 4 is greater than the force exerted by the spring, it rises, and as a larger area is then exposed, its movement upward is very quick, being guided by the brass bush in the body 2. Two ports are drilled in this bush upward to the spring chamber; and two outward through the body to the atmosphere, although only one of each of these is shown in the cut. As the valve moves upward, its lift is determined by the stem 5 striking cap nut 3. It closes the two vertical ports in the bush connecting the valve and spring chambers, and opens the lower ports to the atmosphere. As the air pressure below valve 4 decreases, and the compression of the spring forces the stem and valve downward, the valve restricts the lower ports to the atmosphere and opens those between the valve and spring chambers. The discharge air pressure then has access to the spring chamber. This chamber is

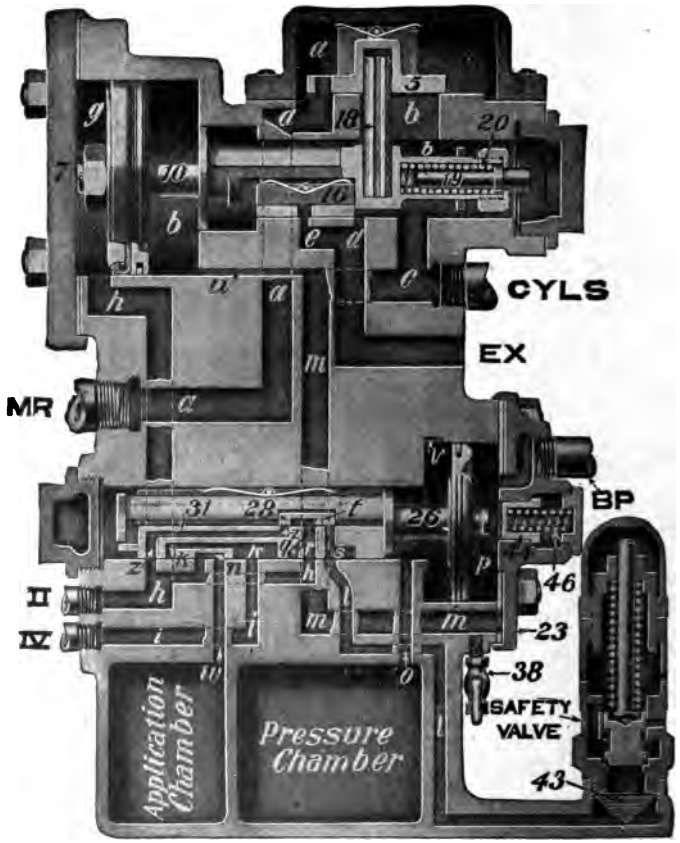
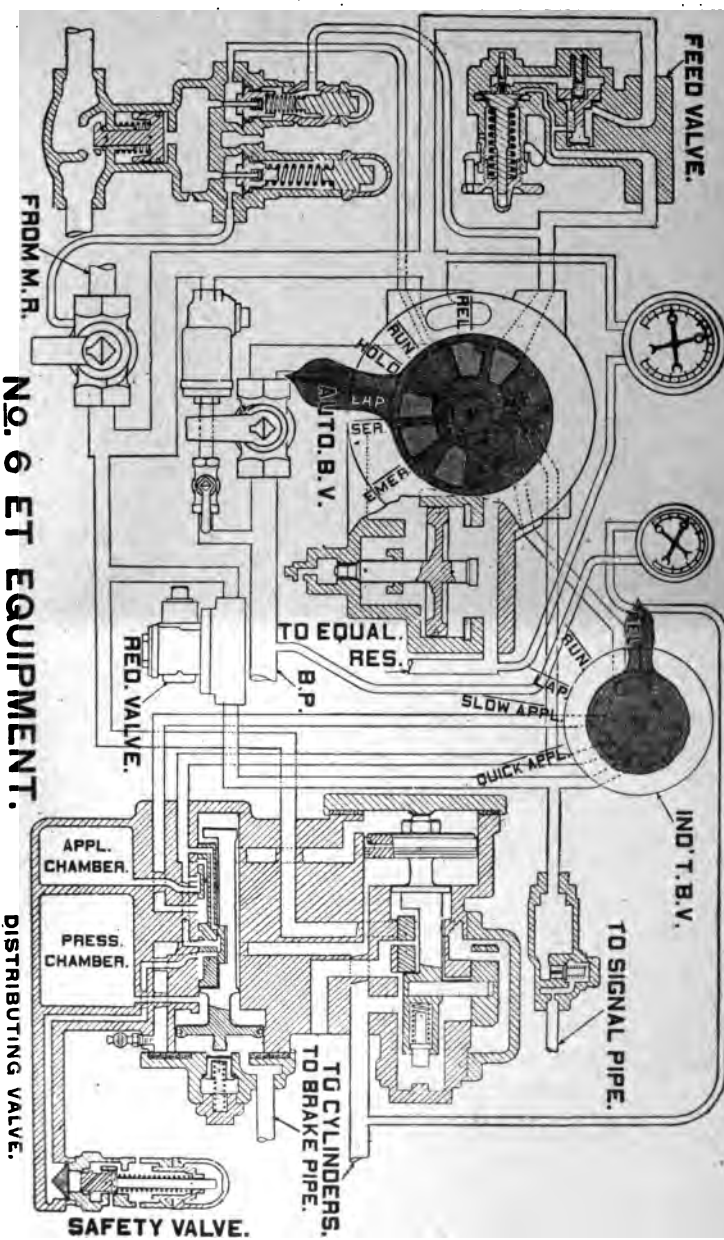


FIG. 14. RELEASE POSITION.
When Locomotive Brake is released by **Independent Brake Valve** After an Automatic **Application.**



No. 6 ET EQUIPMENT.

DISTRIBUTING VALVE.

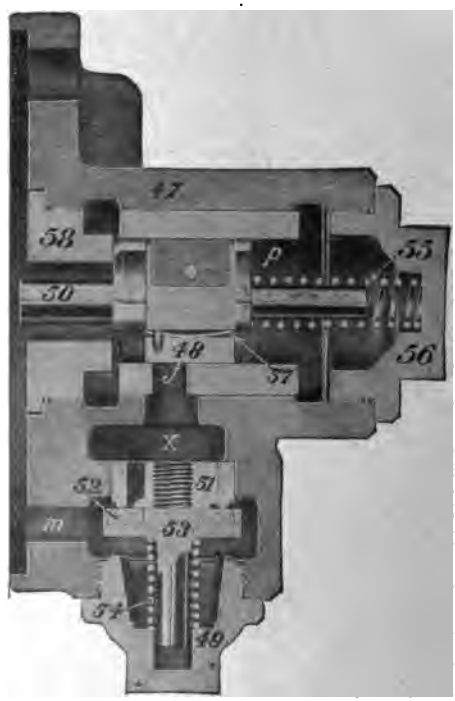
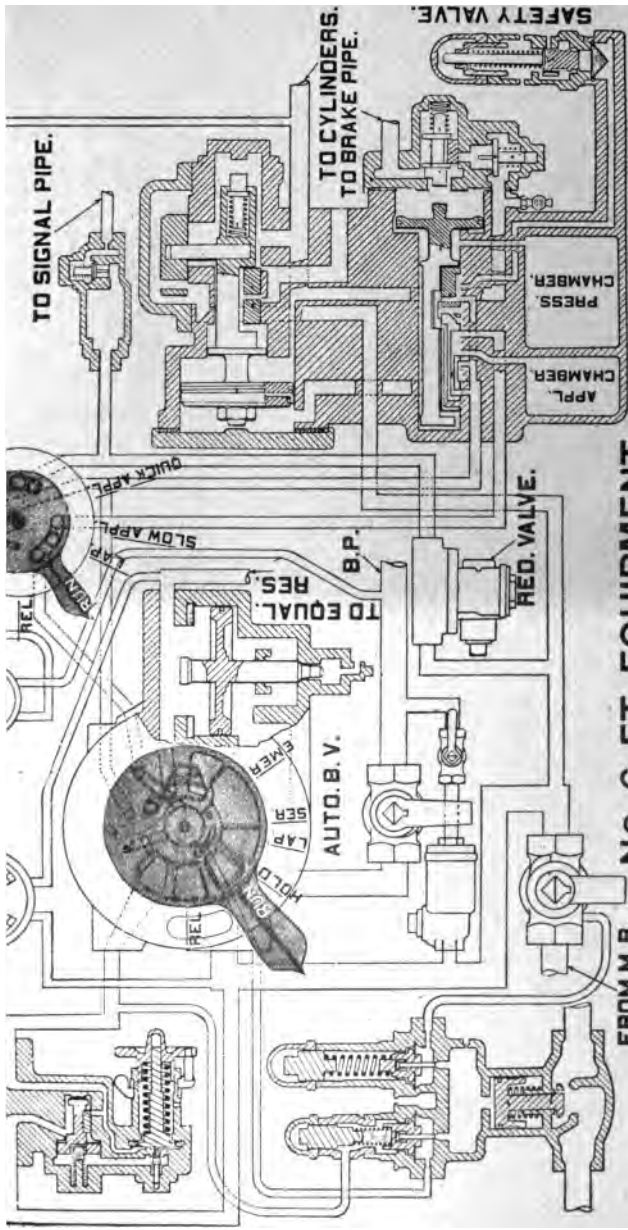


FIG. 15. THE QUICK-ACTION CYLINDER CAP FOR No. 6 DISTRIBUTING VALVE.



RELEASE POSITION QUICK ACTION CAP

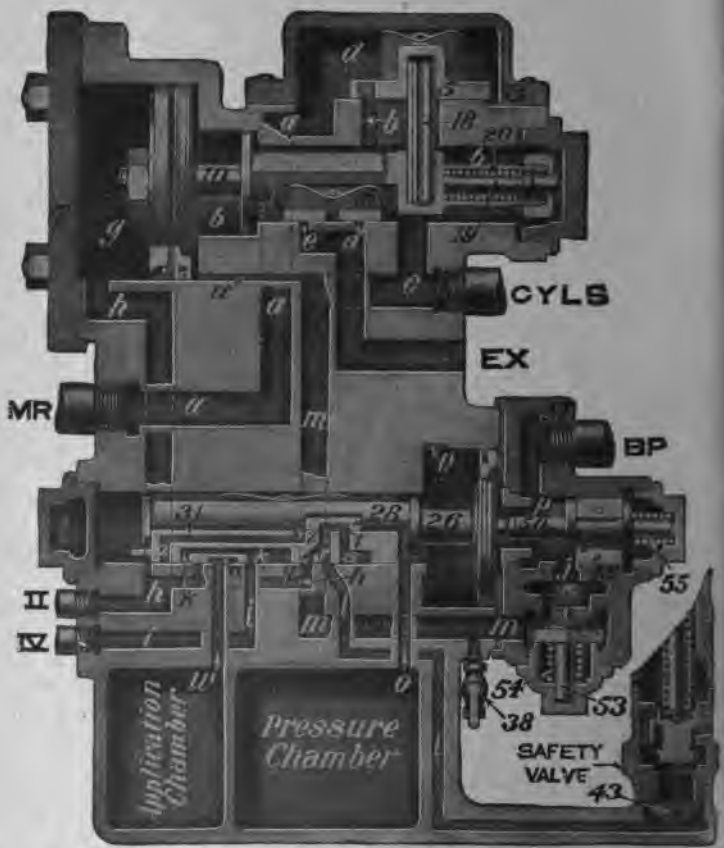
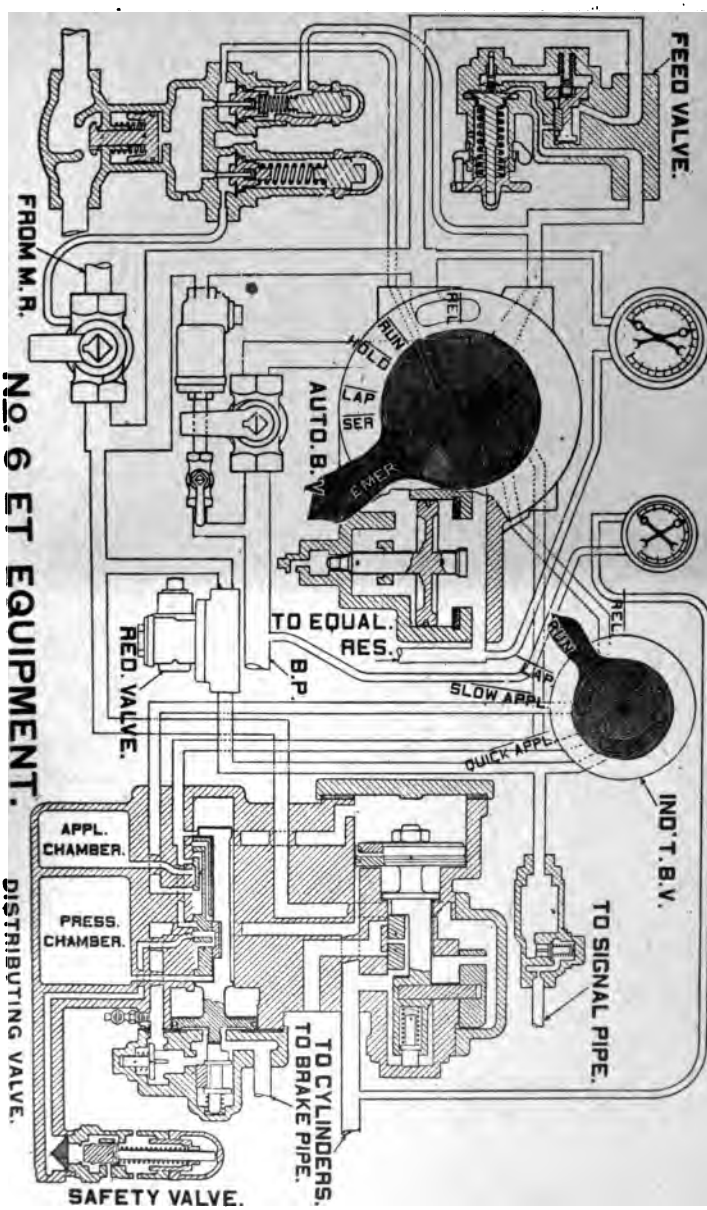


FIG. 16. EMERGENCY POSITION OF NO. 6 DISTRIBUTING VALVE WITH QUICK-ACTION CAP.


No. 6 ET EQUIPMENT.
FEED VALVE.
FROM M.R.
REL
RUN
HOLD
LAP
SER
EMER
AUTO. B.V.
TO EQUAL. RES.
RED. VALVE.
B.P.
SLOW APPL.
QUICK APPL.
IND'T. B.V.
TO SIGNAL PIPE.
APPL. CHAMBER.
PRESS. CHAMBER.
TO CYLINDERS. TO BRAKE PIPE.
DISTRIBUTING VALVE.
SAFETY VALVE.

always connected to the atmosphere by two small holes through the body, 2; the air from the valve chamber enters more rapidly than it can escape through these holes, causing pressure to accumulate above the valve and assist the spring to close it with the "pop" action before mentioned.

The safety valve is adjusted by removing cap nut 3, and screwing up or down on adjusting nut 7. After the proper adjustment is made, cap nut 3 must be replaced and securely tightened, and the valve operated a few times. Particular attention must be given to see that the holes in the valve body are always open, and that they are not changed in size, especially the two upper holes.

This safety valve should be adjusted for 68 pounds. The safety valve, as are all adjustable devices, is more easily and accurately adjusted when done on a shop testing rack.

THE H-6 AUTOMATIC BRAKE VALVE.

This Brake Valve, although modelled to a considerable extent upon the principles of previous valves, is necessarily different in detail, since it not only performs all the functions of such types but also those absolutely necessary to obtain all the desirable operating features of the No. 6 Distributing Valve.

Fig. 18 is taken from a photograph of this brake valve, while Fig. 19 shows two views, the upper one being a plain view with section through the rotary-valve chamber, the rotary valve being removed; the lower one a vertical section. In these views the pipe connections are indicated.

Fig. 20 shows two views of this valve similar to those of Fig. 19, with the addition of a plan or top view of the rotary valve. The six positions of the brake-valve handle are, beginning at the extreme left, Release, Running, Holding, Lap, Service, and Emergency. The names of the parts are as follows: 2, Bottom Case; 3, Rotary-Valve Seat; 4, Top Case; 5, Pipe Bracket; 6, Rotary Valve; 7, Rotary-Valve Key; 8, Key Washer; 9, Handle; 10, Handle Latch Spring; 11, Handle Latch; 12, Handle-Latch Screw; 13, Handle Nut; 14, Handle Lock Nut; 15, Equalizing Piston; 16, Equalizing-Piston Packing Ring; 17, Valve-Seat Upper Gasket; 18, Valve-Seat Lower Gasket; 19, Pipe-Bracket Gasket; 20, Small Union Nut; 21, Brake-Valve Tee; 22, Small Union Swivel; 23, Large Union Nut; 24, Large Union Swivel; 25, Bracket Stud; 26, Bracket-Stud Nut; 27, Bolt and Nut; 28, Cap Screw; 29, Oil Plug; 30, Rotary-Valve Spring; 31, Service-Exhaust Fitting.

Referring to the rotary valve, *a*, *j* and *s* are ports extending directly through it, the latter connecting with a groove in the face; *f* and *k* are cavities in the valve face; *o* is the exhaust cavity; *x* is a port in the face of the valve connecting by a cored passage with *o*; *h* is a port extending from the face over cavity *k*

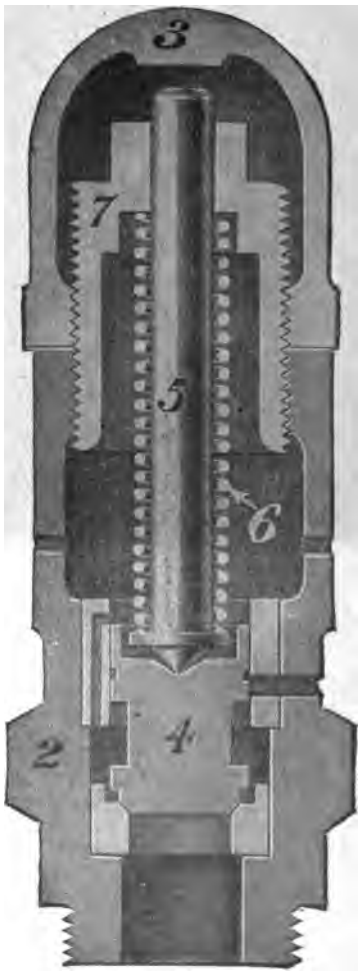


FIG. 17. E-6 SAFETY VALVE

FIG. 18. H-6 AUTOMATIC BRAKE VALVE.

l connecting with exhaust cavity *o*; *n* is a groove in the face ing a small port which connects through a cavity in the valve h cavity *k*. Referring to the ports in the rotary-valve seat, *d* ds to the feed-valve pipe; *b* and *c* lead to the brake pipe; *g* ds to chamber D; EX is the exhaust opening leading out at the k of the valve; *e* is the preliminary exhaust port leading to mber D; *r* is the warning port leading to the exhaust; *p* is the t. leading to the pump governor; *l* leads to the distributing-ve release pipe; *u* leads to the application-cylinder pipe.

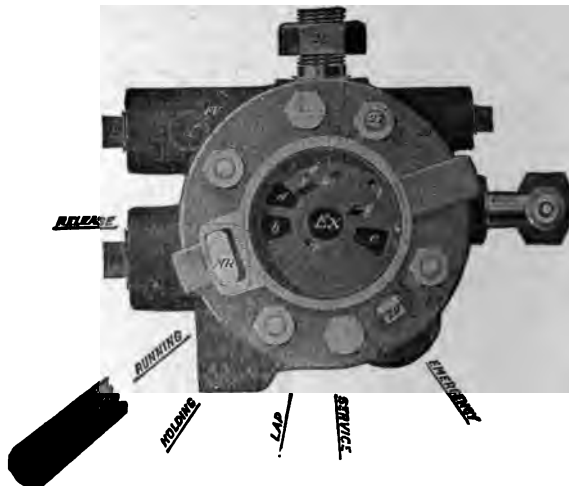
In describing the operation of the brake valve, it will be more dily understood if the positions are taken up in the order in ich they are most generally used, rather than their regular order mentioned previously.

Charging and Release Position. The purpose of this position to provide a large and direct passage from the main reservoir the brake pipe, to permit a rapid flow of air into the latter to) charge the train brake system; (b) quickly release and harge the brakes; but (c) *not* release locomotive brakes, if y are applied.

Air at main-reservoir pressure flows through port *a* in the ary valve and port *b* in the valve seat to the brake pipe. At same time, port *j* in the rotary valve registers with equalizing rt *g* in the valve seat, permitting main-reservoir pressure to ter chamber D above the equalizing piston.

If the handle were allowed to remain in this position, the ake system would be charged to main-reservoir pressure. To oid this, the handle must be moved to Running or Holding posi-n. To prevent the engineer from forgetting this, a small port charges feed-valve pipe air to the atmosphere in release posi-n. Cavity *f* in the rotary valve connects port *d* with warning rt *r* in the seat and allows a small quantity of air to escape o the exhaust cavity EX, which makes sufficient noise to attract engineer's attention to the position in which the valve handle standing. The small groove in the face of the rotary valve ich connects with port *s*, extends to port *p* in the valve seat, owing main-reservoir pressure to flow to the excess-pressure id of the pump governor.

Running Position. This is the proper position of the handle) when the brakes are charged and ready for use; (b) when brakes are not being operated, and (c) to release the locomotive akes. In this position, cavity *f* in the rotary valve connects rts *b* and *d* in the valve seat, affording a large direct passage om the feed-valve pipe to the brake pipe, so that the latter will rge up as rapidly as the feed valve can supply the air, but can-attain a pressure above that for which the feed valve is justed. Cavity *k* in the rotary valve connects ports *c* and *g* in valve seat, so that chamber D and the equalizing reservoir rge uniformly with the brake pipe, keeping the pressure on the sides of the equalizing piston equal. Port *s* in the rotary valve



ROTARY VALVE SEAT.

Connections: FV — Feed Valve Pipe; MR Main Reservoir Pipe; GO—To Governor; III — Distributing-Valve Release Pipe; EX—Emergency Exhaust; II Application cylinder Pipe; BP — Brake Pipe; GA—No. 1 Duplex Air Gauge; ER — Equalizing Reservoir; BP Ex. —Service Exhaust.

FIG. 19. H-6 AUTOMATIC BRAKE VALVE.

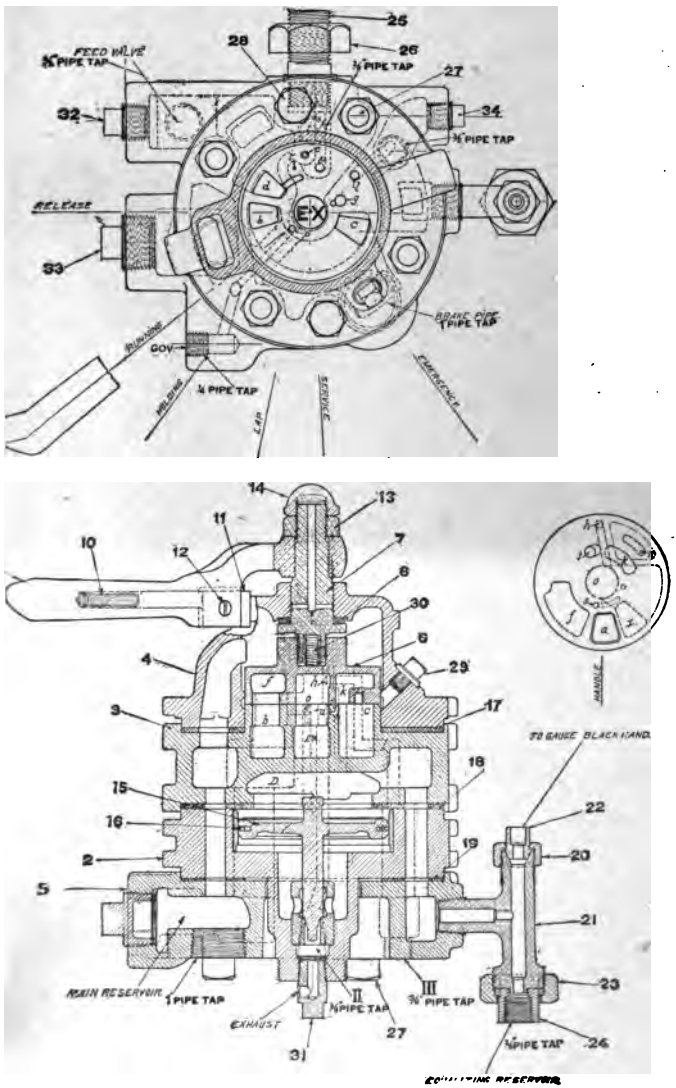


FIG. 20. THE H-6 AUTOMATIC BRAKE VALVE.

registers with port *g* in the valve seat, permitting main-reservoir pressure, which is present at all times above the rotary valve, to pass to the excess-pressure head of the pump governor. Port *h* in the rotary valve registers with port *i* in the seat, connecting the distributing-valve-release pipe through the exhaust cavity EX with the atmosphere.

If the brake valve is in running position when uncharged cars are cut in, or if, after a heavy brake application and release, the handle of the automatic brake valve is returned to running position too soon, the governor will stop the pump until the difference between the hands on gauge No. 1 is less than 20 pounds. The pump stopping from this cause, calls the engineer's attention to the seriously wrong operation on his part, as running position results in delay in charging, and is liable to cause some brakes to stick. Release position should be used until all brakes are released and nearly charged.

Service Position. This position gives a gradual reduction of brake-pipe pressure to cause a service application. Port *h* in the rotary valve registers with port *e* in the valve seat, allowing air from Chamber D and the equalizing reservoir to escape to the atmosphere through cavities *o* in the rotary valve and EX in the valve seat. Port *e* is restricted so as to make the pressure in the equalizing reservoir and chamber D fall gradually.

As all other ports are closed, the fall of pressure in chamber D allows the brake-pipe pressure under the equalizing piston to raise it, and unseat its valve, allowing brake-pipe air to flow to the atmosphere gradually through the opening marked BP Ex. When the pressure in chamber D is reduced the desired amount, the handle is moved to *lap position*, thus stopping any further reduction in that chamber. Air will continue to discharge from the brake-pipe until its pressure has fallen to an amount a trifle less than that retained in chamber D, permitting the pressure in this chamber to force the piston downward gradually and stop the discharge of brake-pipe air. It will be seen, therefore, that the amount of reduction in the equalizing reservoir determines that in the brake pipe, regardless of the length of the train.

The gradual reduction of brake-pipe pressure is to prevent quick action, and the gradual stopping of this discharge is to prevent the premature release of head brakes.

Lap Position. This position is used (a), while holding the brakes applied after a service application until it is desired either to make a further brake-pipe reduction, or to release them; and (b) to prevent loss of main-reservoir pressure in the event of a burst hose, a break-in-two, or the opening of the conductor's valve. All ports are closed.

Release Position. This position, which is used for releasing the train brakes after an application, without releasing the locomotive brakes, is described under *Charging and Release.* The air flowing from the main-reservoir-pipe connection through

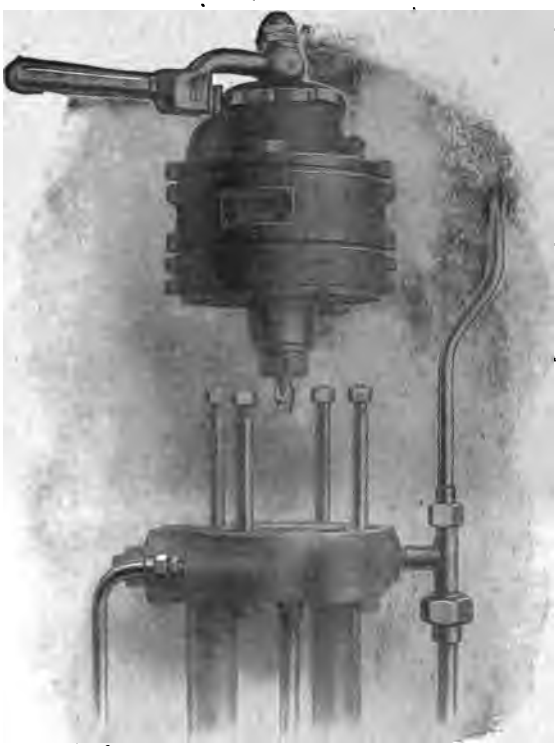


FIG. 21. H-6 AUTOMATIC BRAKE VALVE REMOVED FROM ITS PIPE BRACKET.

port *a* in the rotary valve and port *b* in the valve seat to the brake pipe, raises the pressure in the latter, thereby causing the triple valves and equalizing portion of the distributing valve to go to release position, which releases the train brakes and recharges the auxiliary reservoirs and the pressure-chamber in the distributing valve. When the brake-pipe pressure has been increased sufficiently to cause this, the handle of the brake valve should be moved to either *Running* or *Holding* position; the former when it is desired to release locomotive brakes, and the latter when they are to be still held applied.

Holding Position. This position is so named because the locomotive brakes are held applied while the train brakes recharge to feed-valve pressure. All ports register as in running position, except port *l*, which is closed.

Therefore, the only difference between *Running* and *Holding* Positions is that in the former the locomotive brakes are released, while in the latter they are held applied.

Emergency Position. This position is used when the most prompt and heavy application of the brakes is required. Port *r* in the rotary valve registers with port *c* in the valve seat, making a large and direct communication between the brake pipe and atmosphere through cavity *o* in the rotary valve and EX in the valve seat. This direct passage makes a sudden and heavy discharge of brake-pipe pressure, causing the triple valves and distributing valve to go to the emergency position and give maximum braking power in the shortest possible time.

In this position main-reservoir air flows to the application cylinder through port *j*, which registers with a groove in the seat connecting with cavity *k*; thence through ports *n* in the valve and *n* in the seat to the application-cylinder pipe, thereby maintaining application-cylinder pressure as already described and shown in Fig. 10.

The oil plug 29 is placed in the top case 4, at a point to fix the level of an oil bath in which the rotary valve operates. The position of this oil hole is such that it is impossible to pour oil into the valves in excess of the amount required. This arrangement furnishes thorough lubrication. Valve oil should be used. Leather washer 8 prevents air in the rotary-valve chamber from leaking past the rotary-valve key to the atmosphere. Spring 30 keeps the rotary valve key firmly pressed against washer 8 when no main-reservoir pressure is present. The handle 9 contains latch 11, which fits into notches in the quadrant of the top case, so located as to indicate the different positions of the brake-valve handle. Handle-latch spring 10 forces the latch against the quadrant with sufficient pressure to indicate each position.

To remove the brake valve, close the cocks, as previously explained, and take off nuts 27. (See Fig. 21.) To take the valve proper apart, remove cap screws 28.

The brake valve should be located so that the engineer can

FIG. 22. VALVE, COMPLETE.

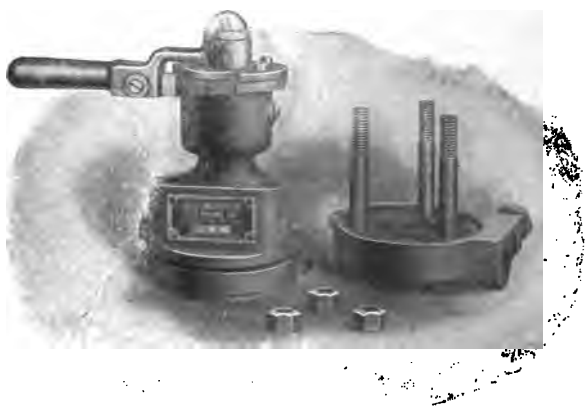


FIG. 23. REMOVED FROM PIPE BRACKET.

S-6 INDEPENDENT BRAKE VALVE.

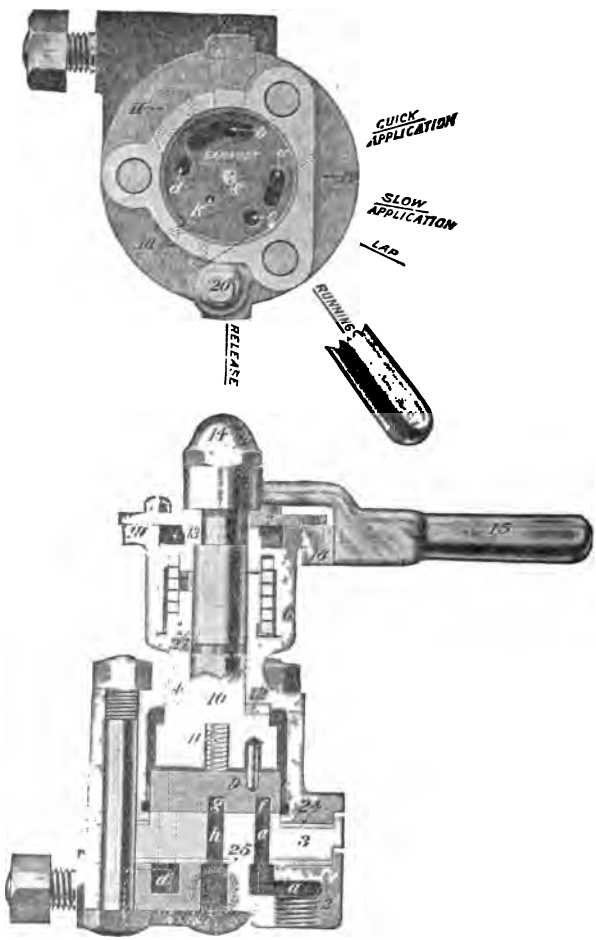


FIG. 24. THE S-6 INDEPENDENT BRAKE VALVE.

Connections: RV- Reducing Valve Pipe; EX—Exhaust; IV—Distributing-Valve Release Pipe to the Distributing Valve; III—Distributing-Valve Release Pipe to the Automatic Brake Valve; II—Application-Clyinder Pipe.

operate it conveniently from his usual position, while looking forward or back out of the side cab window.

THE S-6 INDEPENDENT BRAKE VALVE.

Fig. 22 and 23 illustrate this valve, which is of the rotary type. Fig. 24 shows a vertical section through the center of the valve, and a horizontal section through the valve body, with the rotary valve removed, showing the rotary valve seat. Fig. 25 shows this valve similarly to Fig. 24, with the addition of a top view of the rotary valve. In these views the pipe connections and positions of the handle are indicated. Referring to Fig. 25, the names of parts are as follows:

2, Pipe Bracket; 3, Rotary-Valve Seat; 4, Valve Body; 5, Return-Spring Casing; 6, Return Spring; 7, Cover; 8, Casing Screw; 9, Rotary Valve; 10, Rotary-Valve Key; 11, Rotary-Valve Spring; 12, Key Washer; 13, Upper Clutch; 14, Handle Nut; 15, Handle; 16, Latch Spring; 17, Latch Screw; 18, Latch; 19, Cover Screw; 20, Oil Plug; 21, Bolt and Nut; 22, Bracket Stud; 23, Bracket-Stud Nut; 24, Upper Gasket; 25, Lower Gasket; 26, Lower Clutch; 27, Return-Spring Stop; 28, Cap Screw.

Port *b* in the seat leads to the Reducing-Valve pipe. Port *a* leads to that portion of the Distributing-Valve Release Pipe which connects to the distributing valve at IV (Fig. 7). Port *c* leads to the other portion of the release pipe which connects to the automatic-brake valve at III (Fig. 19). Port *d* leads to the application-cylinder pipe which connects to the distributing valve at II (Fig. 7). Port *h*, in the center, is the exhaust port leading directly down to the atmosphere. Port *k* is the warning port, connecting with the atmosphere. Exhaust cavity *g* in the rotary valve is always in communication at one end with exhaust port *h*. Groove *e* in the face of the valve communicates at one end with a port through the valve. This groove is always in communication with a groove in the seat connecting with supply port *b*, and through the opening just mentioned air is admitted to the chamber above the rotary valve, thus keeping it to its seat. Port *m* connects by a small hole with groove *e*; *f* is a groove in the face of the rotary valve; *l* consists of ports in top and face of valve connected by a passage.

Running Position. This is the position that the independent brake valve should be carried in at all times when the independent brake is not in use. Groove *f* in the rotary valve connects ports *a* and *c* in the valve seat, thus establishing communication between the application cylinder of the distributing valve and port *l* of the automatic brake valve (Fig. 19), so that the distributing valve can be released by the latter. It will also be noted that if the automatic brake valve is in running position, and the independent brakes are being operated, they can be released by simply returning the independent valve to running position, as the

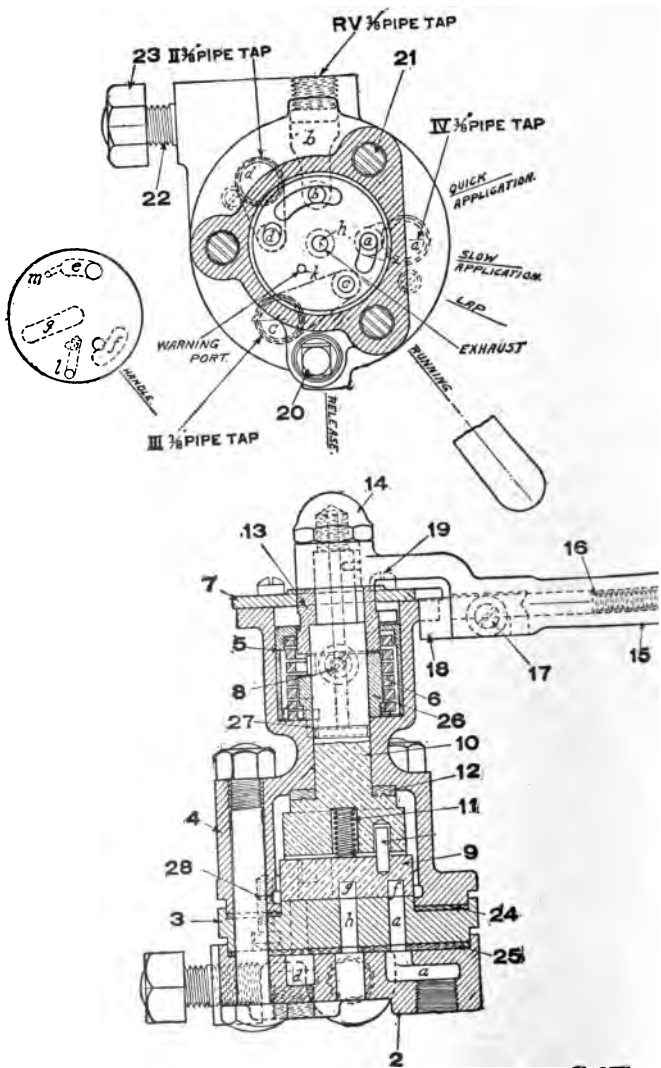


FIG. 25. THE S-6 INDEPENDENT BRAKE VALVE.

application-cylinder pressure can then escape through the release pipe and automatic brake valve.

SLOW-APPLICATION POSITION. To apply the independent brake lightly or gradually, move the brake-valve handle to the slow-application position; port *m* registers with port *d*, allowing air to flow from the reducing-valve pipe through port and groove *b* in the seat, groove *e* in the rotary valve, and the comparatively small port *m* to port *d*; thence through the application-cylinder pipe to the application cylinder of the distributing valve.

Quick-Application Position. To obtain a quick application of the independent brake, move the brake-valve handle to quick-application position; groove *e* then connects ports *b* and *d* directly, making a larger opening between them than in the slow-application position, allowing supply air to flow rapidly from the reducing-valve pipe to the application cylinder of the distributing valve.

Since the supply pressure to this valve is fixed by the regulation of the reducing valve to 45 pounds, this is the maximum cylinder pressure that can be obtained.

Lap Position. This position is used to hold the independent brake applied after the desired cylinder pressure is obtained, at which time all communication between operating ports is closed.

Release Position. This position is used to release the pressure from the application cylinder when the automatic brake valve is not in running position. At such time the offset in cavity *g* registers with port *d*, allowing pressure in the application cylinder to flow through the application-cylinder pipe, ports *d*, *g* and *h* to the atmosphere.

The purpose of return spring 9 is to automatically move the handle 15 from the release to the running position, or from the quick-application to the slow-application position, as soon as the engineer lets go of it. The automatic return from release to running position is to prevent leaving the handle in the former, and thereby make it impossible to operate the locomotive brake with the automatic brake valve. The action of the spring between quick-application and slow-application positions serves to accentuate the latter, so that in rapid operation of the valve, the engineer is less likely to unintentionally pass over it to the quick-application position, thereby obtaining a heavy application of the locomotive brake when only a light one was desired. As a warning to the engineer in case of a broken return spring, port *l* in the face of the rotary registers in release position with port *k* in the seat, allowing air to escape to the atmosphere.

The purpose of the oil plug 20 is the same as that described in the automatic brake valve.

The location of this valve should be governed by the same considerations as those mentioned concerning the automatic brake valve.

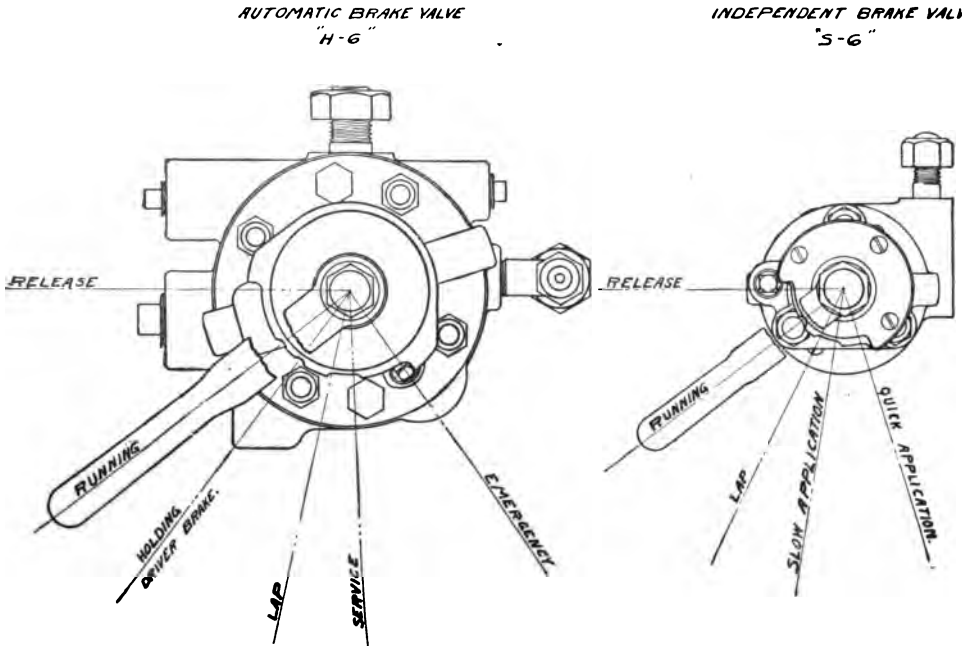


FIG. 26. POSITIONS OF BRAKE-VALVE HANDLES.

Fig. 26 gives a top view of both brake valves, showing the position of their handles.

THE B-6 FEED VALVE.

The B-6 feed valve (Figs. 27 and 28), furnished with the No. 6 equipment, is an improved form of the slide-valve type. It differs from previous ones in charging to the regulated pressure somewhat quicker, and in maintaining the pressure more accurately under the variable conditions of short and long trains, and of good and poor maintenance. Also, it gives high and low brake-pipe pressure control. It is supplied with air directly from the main reservoir. It regulates the pressure in the feed-valve pipe, and also the brake pipe in running and holding positions of the automatic brake valve as the latter then connects these two pipes. It is connected to a pipe bracket located in the piping between the main reservoir and the automatic brake valve, and is interchangeable with previous types.

Figs. 29 and 30 are diagrammatic views of the valve and pipe bracket having the ports and operating parts in one plane to facilitate description. The names of the parts shown in the diagram are as follows: 2, Valve Body; 3, Pipe Bracket; 5, Cap Nut; 6, Piston Spring; 7, Piston Spring Tip; 8, Supply-Valve Piston; 9, Supply Valve; 10, Supply-Valve Spring; 11, Regulating-Valve Cap; 12, Regulating Valve; 13, Regulating-Valve Spring; 14, Diaphragm; 15, Diaphragm Ring; 16, Diaphragm Spindle; 17, Regulating Spring; 18, Spring Box; 19, Upper Stop; 20, Lower Stop; 21, Stop Screw; 22, Adjusting Handle.

This feed valve consists of two sets of parts, the supply and regulating. The supply parts, which control the flow of air through the valve, consist of the supply valve 9 and its spring 10; the supply-valve piston 8 and its spring 6. The regulating parts consist of the regulating valve 12, regulating-valve spring 13, diaphragm 14, diaphragm spindle 16, regulating spring 17, and regulating handle 22.

Main-reservoir air enters through port *a*, *a* to the supply-valve chamber B, forces supply-valve piston 8 to the left, compresses piston spring 6 and causes the port in supply valve 9 to register with port *c* (See Fig. 30). This permits air to pass through ports *c* and *d* to the feed-valve pipe at FVP, and through port *e* to diaphragm chamber L.

Regulating valve 12 is then open and connects chamber G, on the left of piston 8, to the feed-valve pipe through passage *h*, port *k*, chamber L, and passage *e*, *d*, *d*. Air feeding by the piston cannot accumulate above feed-valve pipe pressure. When regulating valve 12 is closed, the pressure on the left of piston 8 quickly rises, to the main-reservoir pressure on the right, and piston spring 6 forces piston 8 and supply valve 9 to the right, closes port *c*, and stops the flow to the feed-valve pipe.

registers with port *p* in the valve seat, permitting main-reservoir pressure, which is present at all times above the rotary valve, to pass to the excess-pressure head of the pump governor. Port *h* in the rotary valve registers with port *l* in the seat, connecting the distributing-valve-release pipe through the exhaust cavity EX with the atmosphere.

If the brake valve is in running position when uncharged cars are cut in, or if, after a heavy brake application and release, the handle of the automatic brake valve is returned to running position too soon, the governor will stop the pump until the difference between the hands on gauge No. 1 is less than 20 pounds. The pump stopping from this cause, calls the engineer's attention to the seriously wrong operation on his part, as running position results in delay in charging, and is liable to cause some brakes to stick. Release position should be used until all brakes are released and nearly charged.

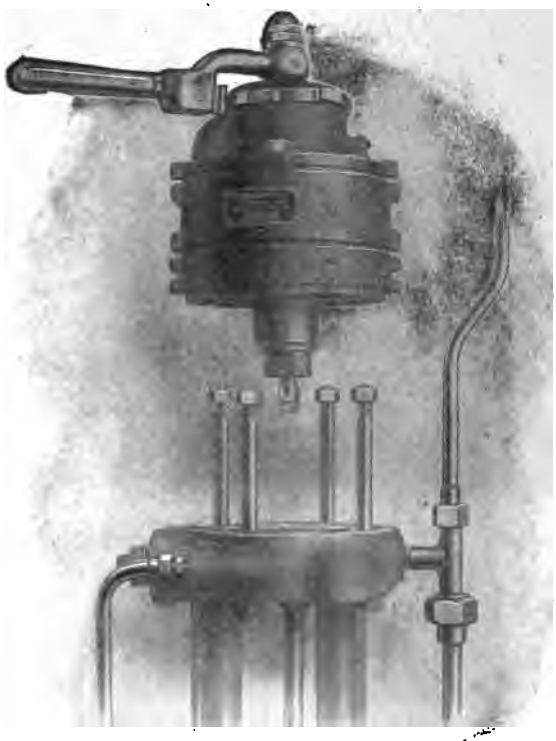
Service Position. This position gives a gradual reduction of brake-pipe pressure to cause a service application. Port *h* in the rotary valve registers with port *e* in the valve seat, allowing air from Chamber D and the equalizing reservoir to escape to the atmosphere through cavities *o* in the rotary valve and EX in the valve seat. Port *e* is restricted so as to make the pressure in the equalizing reservoir and chamber D fall gradually.

As all other ports are closed, the fall of pressure in chamber D allows the brake-pipe pressure under the equalizing piston to raise it, and unseat its valve, allowing brake-pipe air to flow to the atmosphere gradually through the opening marked BP Ex. When the pressure in chamber D is reduced the desired amount, the handle is moved to *lap position*, thus stopping any further reduction in that chamber. Air will continue to discharge from the brake-pipe until its pressure has fallen to an amount a trifle less than that retained in chamber D, permitting the pressure in this chamber to force the piston downward gradually and stop the discharge of brake-pipe air. It will be seen, therefore, that the amount of reduction in the equalizing reservoir determines that in the brake pipe, regardless of the length of the train.

The gradual reduction of brake-pipe pressure is to prevent quick action, and the gradual stopping of this discharge is to prevent the premature release of head brakes.

Lap Position. This position is used (a), while holding the brakes applied after a service application until it is desired either to make a further brake-pipe reduction, or to release them; and (b) to prevent loss of main-reservoir pressure in the event of a burst hose, a break-in-two, or the opening of the conductor's valve. All ports are closed.

Release Position. This position, which is used for releasing the train brakes after an application, without releasing the locomotive brakes, is described under ***Charging and Release.*** The air flowing from the main-reservoir-pipe connection through



21. H-6 AUTOMATIC BRAKE VALVE REMOVED FROM ITS PIPE BRACKET.

port *a* in the rotary valve and port *b* in the valve seat to the brake pipe, raises the pressure in the latter, thereby causing the triple valves and equalizing portion of the distributing valve to go to release position, which releases the train brakes and recharges the auxiliary reservoirs and the pressure chamber in the distributing valve. When the brake-pipe pressure has been increased sufficiently to cause this, the handle of the brake valve should be moved to either *Running* or *Holding* position; the former when it is desired to release locomotive brakes, and the latter when they are to be still held applied.

Holding Position. This position is so named because the locomotive brakes are held applied while the train brakes recharge to feed-valve pressure. All ports register as in running position, except port *l*, which is closed.

Therefore, the only difference between *Running* and *Holding* Positions is that in the former the locomotive brakes are released, while in the latter they are held applied.

Emergency Position. This position is used when the most prompt and heavy application of the brakes is required. Port *x* in the rotary valve registers with port *c* in the valve seat, making a large and direct communication between the brake pipe and atmosphere through cavity *o* in the rotary valve and EX in the valve seat. This direct passage makes a sudden and heavy discharge of brake-pipe pressure, causing the triple valves and distributing valve to go to the emergency position and give maximum braking power in the shortest possible time.

In this position main-reservoir air flows to the application cylinder through port *j*, which registers with a groove in the seat connecting with cavity *k*; thence through ports *n* in the valve and *u* in the seat to the application-cylinder pipe, thereby maintaining application-cylinder pressure as already described and shown in Fig. 10.

The oil plug 29 is placed in the top case 4, at a point to fix the level of an oil bath in which the rotary valve operates. The position of this oil hole is such that it is impossible to pour oil into the valves in excess of the amount required. This arrangement furnishes thorough lubrication. Valve oil should be used. Leather washer 8 prevents air in the rotary-valve chamber from leaking past the rotary-valve key to the atmosphere. Spring 30 keeps the rotary valve key firmly pressed against washer 8 when no main-reservoir pressure is present. The handle 9 contains latch 11, which fits into notches in the quadrant of the top case, so located as to indicate the different positions of the brake-valve handle. Handle-latch spring 10 forces the latch against the quadrant with sufficient pressure to indicate each position.

To remove the brake valve, close the cocks, as previously explained, and take off nuts 27. (See Fig. 21.) To take the valve proper apart, remove cap screws 28.

The brake valve should be located so that the engineer can

FIG. 22. VALVE, COMPLETE.

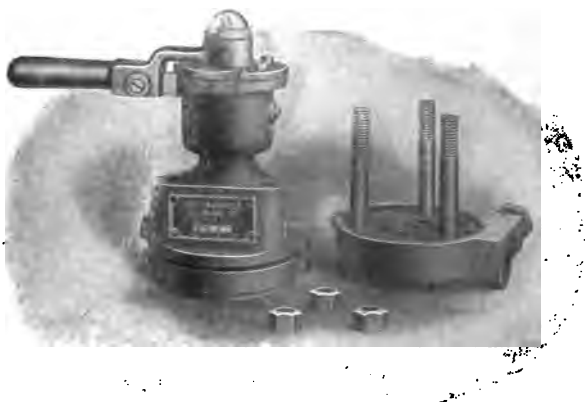


FIG. 23. REMOVED FROM PIPE BRACKET.

S-6 INDEPENDENT BRAKE VALVE.

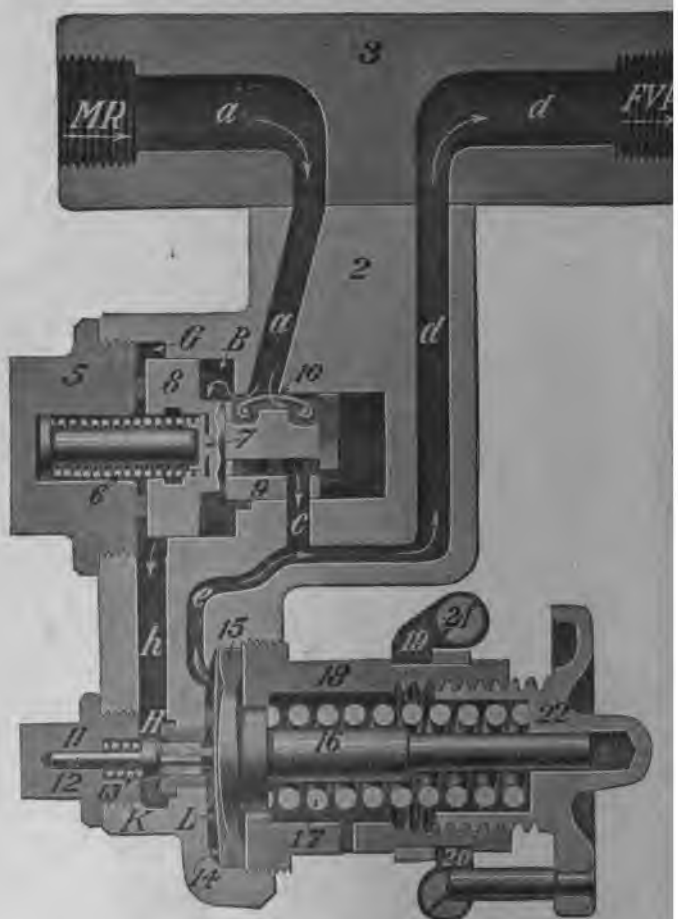


FIG. 30. DIAGRAM OF B-6 FEED VALVE, OPEN.
Connections: See Fig. 29.

diaphragm 28. Air from the feed-valve pipe enters at the ction FVP to chamber *f* above diaphragm 28, adding to the ıre of regulating spring 27 in holding it down. As this g is adjusted to about 20 pounds, this diaphragm will be down until the main-reservoir pressure in chamber *d* slightly ds the combined air and spring pressure in chamber *f*. At time, diaphragm 28 will rise, unseat its pin valve, and allow o flow to chamber *b* above the governor piston, forcing the r downward, compressing its spring and restricting the flow eam past steam valve 5 to the point where the pump will just ly the leakage in the brake system. When main-reservoir ure in chamber *d* becomes reduced, the combined spring and pressure above the diaphragm forces it down, seating its pin e. As chamber *b* is always open to the atmosphere through small vent port *c*, the pressure in chamber *b* above the gov- r piston will then escape to the atmosphere and allow the on spring, and steam pressure below valve 5, to raise it and governor piston to the position shown. Since the connection n the main reservoir to chamber *d* is open only when the lle of the automatic brake valve is in release, running or hold- positions, in the other positions this governor head is cut out. connection marked MR in the maximum-pressure head should connected to the main reservoir cut-out cock, or to the pipe ıecting the two main reservoirs, so as to be *always* in com- ication with the main reservoir, so that when the excess-pres- head is cut out by the brake valve, or by the main-reservoir out cock, this head will control the pump. When main-reser- pressure in chamber *a* exceeds the adjustment of spring 19 he maximum-pressure head, diaphragm 20 will raise its pin e and allow air to flow in to chamber *b* above the governor on, controlling the pump as above described. The adjustment spring 19 thus forms the maximum limit of main-reservoir sure, as for example when the train brakes are applied.

As each governor head has a vent port *c*, from which a small unt of air escapes whenever pressure is present in port *b*, ıvoid an unnecessary waste of air, one of these should be gged.

To adjust the excess-pressure head of this governor, remove nut 25 and turn adjusting nut 26 until the compression of ng 27 gives the desired difference between main reservoir and te-pipe pressures, the handle of the automatic brake valve g in running position. To adjust the maximum-pressure head ve cap nut 17 and turn adjusting nut 18 until the compres- of spring 19 causes the pump to stop at the maximum main- rvoir pressure required, the handle of the automatic brake e now being on lap. It is recommended that spring 27 be ad- ed for 20 pounds excess pressure, and spring 19 for a pressure ing from 120 to 140 pounds, depending on the service.

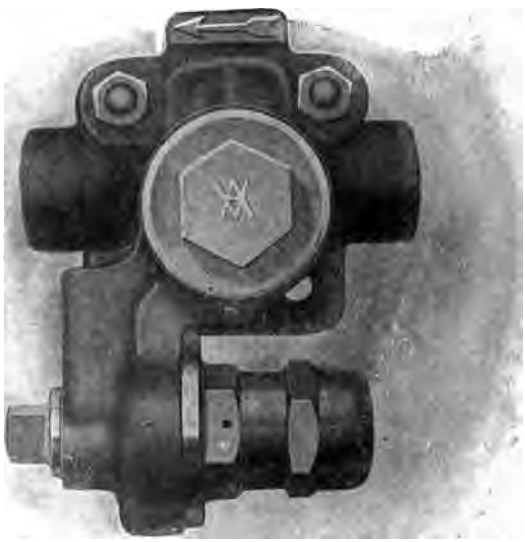


FIG. 31. THE C-6 REDUCING VALVE.

THE "DEAD-ENGINE" FEATURE.

e "Dead Engine" feature shown in Fig. 1-A, and 1-B at Z, is for the operation of the locomotive brakes when mp on a locomotive in a train is inoperative through being a down, or by reason of no steam. Fig. 33 shows the com- strainer, check valve, and choke fitting. As these parts are quired at other times, a cut-out cock is provided. This cock be kept closed except under the conditions just mentioned. ir for operating the brakes on such a locomotive must then plied through the brake pipe from the locomotive operating ain brakes.

ith the cut-out cock open, air from the brake pipe enters , Fig. 33, passes through the curled hair strainer, lifts check 4, held to its seat by a strong spring, passes through the bushing, and out at MR to the main-reservoir, thus provid- ressure for operating the brakes on this locomotive. The e-heading cock should be closed, and the handle of each valve should be in running position. Where absence of in the boiler, or other reason, justifies keeping the maximum g power of such a locomotive lower than the standard, this e accomplished by reducing the adjustment of the safety on the distributing valve. It can also be reduced at will by dependent brake valve.

e strainer protects the check valve and choke from dirt. 2 over the check valve insures this valve seating and, while ng an ample pressure to operate the locomotive brakes, the main-reservoir pressure somewhat lower than the brake- ressure, thereby reducing any leakage from the former. The prevents a sudden drop in brake-pipe pressure and the appli- of the train brakes, as would otherwise occur with an un- d main reservoir cut in to a charged brake pipe. In this, it es similarly to the feed groove in a triple valve.

MANIPULATION AND TRAIN HANDLING.

e following instructions are general, and must necessarily be mented to a limited extent to fully meet the varying local ions on different railways.

e instructions for manipulating the ET equipment are prac- the same as those given for the combined automatic and ht air brake; therefore, no radical departure from present ds of brake manipulation is required to get the desired s.

e necessary instructions are briefly as follows:

hen not in use, carry the handles of both brake valves in run- position.

apply the brakes in service, move the handle of the auto- brake valve to the *service position,* making the required

brake-pipe reduction, then back to *lap position* which is the or for holding brakes applied.

To release the train brakes, move the handle to the *release p sition* and hold it there until all triple valves are in release pos tion; if locomotive brakes are to be released at once, use *runnin position;* but if they are to be held for a time, move to *holdin position,* and then graduate them off by short, successive move ments between running and holding positions. With all freigh trains and especially long ones, both release and holding position must, of course, be used very much longer than with short trains particularly passenger.

To apply the brakes in emergency, move the handle of th automatic brake valve quickly to emergency position and leave i there until the train stops or the danger is past.

To make a smooth and accurate *two-application passenger stop* make the first application sufficiently heavy to bring the speed of train down to about 15 miles per hour at a convenient distance from the stopping point, then release train brakes by moving the handle to *release position,* then the locomotive brakes by moving it to *running position* for two or three seconds before re-applying. A little experience with the E. T. equipment will enable the engineer to make smooth and accurate stops with much greater ease than was heretofore possible.

When using *the independent brake only,* the handle of the automatic brake valve should be carried in *running position.* The independent application may be released by moving the independent-brake-valve handle to *running position.* Independent release position is for use only when the automatic-brake-valve handle is not in running position, as an example, when the engineer desires to release the engine brakes independent of the train brakes.

While handling long trains of cars, in road or switching service, the independent brake should be operated with care, to prevent damage to cars and lading, caused by running the slack in or out too hard. In cases of emergency arising while the independent brake is applied, apply the automatic brake instantly. The safety valve will restrict the brake-cylinder pressure to the proper maximum.

The brakes on the locomotive and on the train should be alternated in heavy grade service to prevent overheating of driving wheel tires and to assist the pressure retaining valves in holding the train while the auxiliary reservoirs are being recharged. This is done by keeping the locomotive brakes released by use of the independent brake valve when train brakes are applied, and applying locomotive brakes just before train brakes are released, and then releasing locomotive brakes after train brakes are reapplied.

When all brakes are applied automatically, to graduate off or entirely release the *locomotive brakes only,* use *release position* of the independent brake valve.

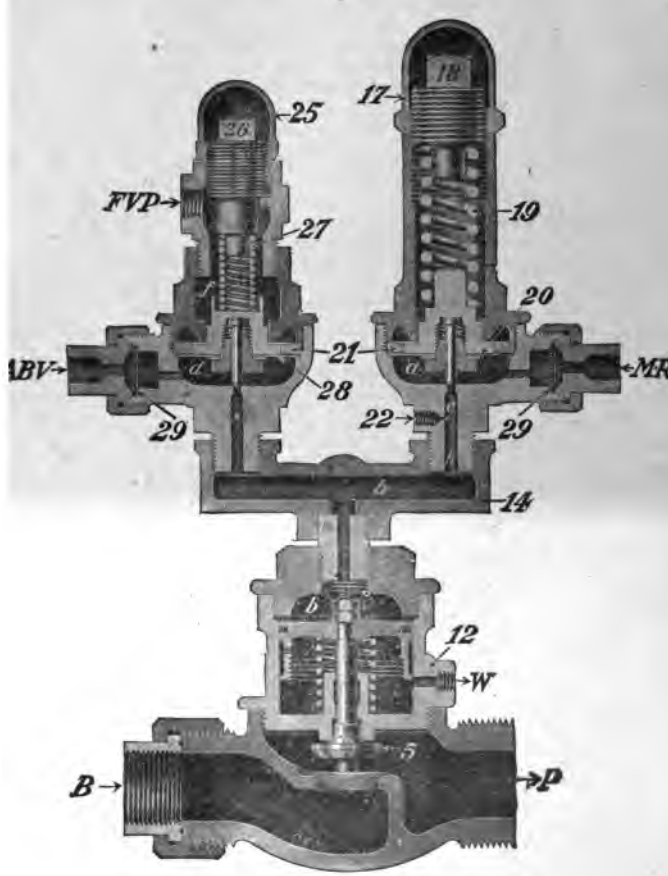


FIG. 32. THE SF-4 PUMP GOVERNOR.

The red hand of gauge No. 2 (Fig. 1) will show at all ti the pressure in the locomotive brake cylinders, and this i should be observed in brake manipulation.

Release Position of the Independent Brake Valve will rele the locomotive brakes under any and all conditions.

The train brakes should invariably be released before deta ing the locomotive, holding with hand brakes where necessa This is especially important on a grade, as there is otherwise assurance that the car, cars or train so detached will not sta when the air brakes leak off, as they may in a short time whe there is considerable leakage.

The automatic brakes should never be used to hold a standin locomotive or a train even where the locomotive is not detache for longer than ten minutes, and not for such time if the grade very steep or the condition of the brakes is not good. The safe method is to hold with hand brakes only and keep the auxiliar reservoirs fully charged, so as to guard against a start fro brakes leaking off, and to be ready to obtain any part of fu braking power immediately on starting.

The independent brake is a very important safety feature i this connection, as it will hold a locomotive with a leaky throttl or quite a heavy train on a fairly steep grade if, as the automati brakes are released, the slack is prevented from running in or out (depending on the tendency of the grade) and giving the locomo tive a start. To illustrate—the best method to make a stop on descending grade is to apply the independent brake heavily as th stop is being completed, thus bunching the train solidly; then when stopped, place and *leave* the handle of the independent brak valve in application position; then release the automatic brake and keep them charged. Should the independent brake be unabl to prevent the train from starting, the automatic brakes will be come sufficiently recharged to make an immediate stop; in suc an event enough hand brakes should at once be applied as ar necessary to assist the independent brake to hold the train. *Man runaways and some serious wrecks have resulted through failur to comply with the foregoing instructions.*

When leaving the engine while doing work about it, or whe it is standing at a coal chute or water plug, always leave th independent brake valve handle in *application position.*

In case the automatic brakes are applied by a bursted hose, break in two or the use of a conductor's valve, place the handle o the automatic brake valve in lap position.

Where there are two or more locomotives in a train, the *doubl heading cock must be closed*, and the handle of the automat brake valve must be carried in *running position* on each except th one from which the brakes are being operated.

Before leaving the round house, the engineer should try th brakes with both brake valves, and see that no serious leaks exis

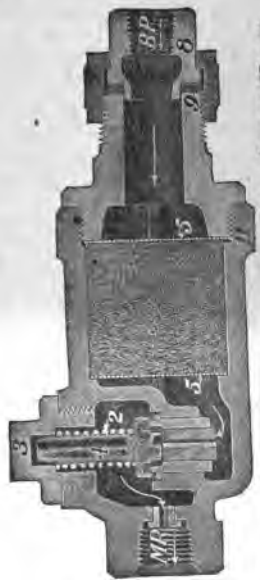


FIG. 33. COMBINED AIR STRAINER AND CHECK VALVE.

The pipes H and I (Fig. 1-B) between the distributing valve and the brake valves should be absolutely tight.

QUESTIONS AND ANSWERS ON NO. 6 ET LOCOMOTIVE BRAKE EQUIPMENT.*

Q. 1. What is the No. 6 ET Equipment?

A. It is a brake equipment for engine and tender adapted to all kinds of engines and classes of service and combines the operative features of the standard automatic, straight-air, high-speed, and double pressure control brake equipments, with many additional features.

Q. 2. Is the operation of the train brakes affected by the ET Equipment?

A. No; the operation of the train brakes is the same with this equipment as with former locomotive brake equipments.

Q. 3. What is meant by the term *train* brakes?

A. All brakes in the train except those upon the locomotive from which the brakes are being handled.

Q. 4. What is meant by the term *locomotive* brake?

A. The brake upon the engine and tender.

Q. 5. What new features of operation are obtainable with the ET Equipment?

A. (a) Locomotive brake may be used with or independently of the train brakes, whether the train brakes are in use or not.

(b) Uniform and proper cylinder pressure is obtained regardless of piston travel or leakage.

(c) Cylinder pressure is automatically maintained regardless of brake cylinder leakage.

(d) Locomotive brake can be graduated on or off with either the automatic or the independent brake valves.

(e) Increased flexibility in service operations, with increased braking power in emergency applications.

(f) Brakes on second locomotive or helper can be released or applied without in any way interfering with any other brakes in the train.

PARTS OF THE EQUIPMENT.

Q. 6. Name the essential parts of the ET Equipment.

A. 1, Air Compressor; 2, Main Reservoir; 3, Duplex Pump Governor; 4, Feed Valve; 5, Reducing Valve; 6, Automatic Brake Valve with Equalizing Reservoir; 7, Independent Brake Valve; 8,

*Formulated by The Air Brake Association.

Distributing Valve and Double Reservoir; 9, Two Duplex Air Gages; 10, Combined Air Strainer and Check Valve; 11, Choke Fitting; 12, Locomotive Brake Cylinders; also various cocks and fittings. (See Figs. 1-A and 1-B.)

Q. 7. What special parts are sometimes used?

A. (a) Quick-action Cylinder Cap for Distributing Valve.
(b) Combined Air Strainer and Check Valve for Train Air Signal System.
(c) Choke Fitting for Truck Brake.

Q. 8. What furnishes the compressed air for the brake system?

A. The Air compressor.

Q. 9. What operates the air compressor?

A. Steam from the locomotive boiler.

Q. 10. After leaving the compressor, where does the air go?

A. Through the radiating pipes to the main reservoir.

Q. 11. What is the purpose of the radiating pipe?

A. To cool the air after leaving the compressor.

Q. 12. What is the purpose of the main reservoirs?

A. The main reservoirs provide a place for the storage of an abundant supply of compressed air for use in promptly releasing the brakes on the locomotive and train and for recharging the brake system. They also assist in cooling the compressed air and collect moisture, oil or other foreign matter, allowing only clean, dry air to pass to the brake system.

Q. 13. What controls the air pressure in the main reservoirs?

A. The Duplex pump governor.

Q. 14. How does the pump governor control the main reservoir pressure?

A. It automatically regulates the supply of steam to the compressor so as to maintain normal pressure in the main reservoirs.

Q. 15. What connects the main reservoirs to the brake system?

A. The main reservoir pipe.

Q. 16. What provision is made for cutting off the main reservoirs from the rest of the brake system?

A. A cock in the main reservoir pipe close to the main reservoir, known as the "main reservoir cut-out cock."

Q. 17. Where do the pipe branches lead to from the main servoir pipe?

A. (a) To the duplex pump governor.
(b) To the main reservoir hand of the duplex air gage.
(c) To the automatic brake valve.

(d) To the feed valve.
(e) To the reducing valve.
(f) To the distributing valve.
(g) To the dead engine fixtures.
(h) Other branches leading to various air-using devic on the locomotive, such as sanders, water-scoop, et

Q. 18. What is the purpose of the feed valve?

A. To automatically maintain a predetermined pressure i the brake system, lower than that carried in the main reservoir

Q. 19. To what does the feed valve pipe connect?

A. To the automatic brake valve, and to the spring chambe of the excess pressure head of the duplex pump governor.

Q. 20. What is the purpose of the reducing valve?

A. It automatically reduces the air pressure from the mai reservoirs to the proper pressure used with the independent brak and train air signal system.

Q. 21. What is the purpose of the automatic brake valve?

A. (a) To allow air to flow from the brake system for charging it.

(b) To discharge air from the brake pipe to the atmosphere to apply the brakes.
(c) To prevent the flow of air to or from the brake pipe when holding the brakes applied.
(d) To hold applied or release the locomotive brake as desired while releasing train brakes.
(e) To allow air to flow to the brake system for the purpose of releasing the brakes and recharging the system.
(f) To control the flow of air to the diaphragm chambe of the excess pressure head of the duplex pump governor.
(g) To allow main reservoir to flow to the application cylinder of the distributing valve in *emergency* position.

Q. 22. What is the purpose of the independent brake valve

A. To operate the brakes on the engine and tender independent of the train brakes.

Q. 23. State briefly the purpose of the distributing valve.

A. (a) To automatically control the flow of air from th main reservoirs to the engine and tender brak cylinders when applying the brakes.

(b) To automatically maintain the brake cylinder pressu against leakage, keeping it constant, when holdi the brake applied.

(c) To automatically control the flow of air from the engine and tender brake cylinders to the atmosphere when releasing the brake.

Q. 24. What is the purpose of the locomotive brake cylinders?

A. The brake cylinder is that part of the air brake equipment in which the force contained in the compressed air is transformed into a mechanical force which is transmitted through a suitable combination of rods and levers to the brake shoes and applies them to the wheels.

H-6 AUTOMATIC BRAKE VALVE.

Q. 25. How many positions has the H-6 Brake Valve?

A. Six.

Q. 26. Name the positions beginning at the left.

A. *Release, Running, Holding, Lap, Service* and *Emergency* (see Fig. 19).

Q. 27. Name and describe the purpose of the pipe connections to the H-6 Brake Valve.

A. (a) Main Reservoir Pipe. To connect the main reservoirs to the chamber above the rotary valve and permit a free flow of high pressure air into the brake pipe when the brake valve handle is in *release* position.

(b) Feed Valve Pipe. To connect the feed valve to the underside of the rotary valve. When the brake valve handle is in *running* position this pipe is open to the brake pipe, thus permitting the feed valve to maintain a constant brake pipe pressure below that in the main reservoirs.

(c) Equalizing Reservoir Pipe. This connects the chamber above the equalizing piston to the equalizing reservoir and the equalizing reservoir gage.

(d) Brake Pipe. To connect the distributing valve on the locomotive and the triple valve on each car to the space underneath the equalizing discharge piston and the underside of rotary valve.

(e) Governor Pipe. This makes a connection from the rotary valve chamber (main reservoir pressure) to the underside of the diaphragm of the excess pressure governor head when the brake valve handle is in either *release, running* or *holding* positions.

(f) Distributing Valve Release Pipe. This makes a connection from the application chamber of the distributing valve (through the independent brake valve) to the underside of the automatic rotary

valve, forming a connection to the atmosphere when both brake valve handles are in *running* position.

(g) Application cylinder Pipe. This connects the underside of the automatic rotary valve directly to the application cylinder of the distributing valve. In *emergency* position of the brake valve handle this pipe is open to the chamber above the rotary valve (main reservoir pressure) through the blow-down timing port.

Q. 28. When is *release* position used?

A. When it is desired to quickly charge the brake system and to release brakes on long trains.

Q. 29. Explain the flow of air through the automatic brake valve when in *release* position.

A. Air from the main reservoirs flows directly to the brake pipe, equalizing reservoir and pump governor. Air from the feed valve flows through the warning port to the atmosphere.

Q. 30. When is *running* position used?

A. When running along the road to maintain a predetermined brake pipe pressure lower than that carried in the main reservoirs, to release the engine and tender brakes and also to release the brakes on short trains.

Q. 31. Explain the flow of air through the automatic brake valve when in *running* position.

A. (a) Air from the feed valve flows to the brake pipe and to the equalizing reservoir.

(b) Air from the main reservoirs flows directly to the diaphragm chamber of the excess pressure head of the duplex pump governor.

(c) Air from the distributing valve release pipe flows to the atmosphere.

Q. 32. When is *holding* position used?

A. When it is desired to hold the engine and tender brakes applied by means of the automatic brake valve while releasing or recharging the train brakes.

Q. 33. Explain the flow of air through the automatic brake valve when in *holding* position.

A. The flow of air through the automatic brake valve in holding position is the same as when in ***running*** position with one exception, namely: air from the distributing valve release is prevented from flowing to the atmosphere.

Q. 34. When is *lap* position used?

A. When holding all the brakes applied after an automatic application. The handle should never be carried in this position except while bringing the train to a stop.

Q. 35. Is there any flow of air to the brake system through the automatic brake valve when in *lap* position?

A. No.

Q. 36. When is *service* position used?

A. When it is desired to make an automatic application of the brakes.

Q. 37. Explain fully the flow of air through the automatic brake valve when in *service* position.

A. In the automatic brake valve is a piston and valve called the equalizing discharge piston and valve, No. 15, Fig. 19. The underside of this piston is directly connected to the brake pipe. The chamber *D*, above piston 15, is directly connected to the equalizing reservoir *ER* and to a small port *e* in the rotary valve seat called the preliminary exhaust port. In *service* position the preliminary exhaust port is open to the atmosphere through port *h* and exhaust cavity *o* (see small view plan of Rotary Valve at right, Fig. 20) in the rotary valve, thus allowing air from the equilizing reservoir and the chamber *D* above the equalizing discharge piston to flow to the atmosphere. This reduces the pressure on the top of the piston below the brake pipe pressure on the underside, which raises the equalizing discharge piston 15 and permits brake pipe air to flow to the atmosphere through the service exhaust fitting *B. P. Ex.* The flow of air from the equalizing reservoir to the atmosphere continues until the brake valve handle is returned to *lap* position. This closes the preliminary exhaust port *e*, and prevents further decrease of pressure in the equalizing reservoir and chamber *D*. Air will continue to discharge from brake pipe until its pressure has been reduced slightly lower than that remaining in chamber *D*. The higher pressure on the top of the piston then forces the valve to its seat and prevents further reduction of brake pipe pressure.

Q. 38. What is the purpose of the service exhaust fitting?

A. To fix the maximum permissible opening from the brake pipe to the atmosphere when making a service application.

Q. 39. Is it important that all H-6 brake valves be provided with this fitting?

A. Yes.

Q. 40. When is *emergency* position used?

A. When it is desired to make the shortest possible stop. In such case the handle should be moved to *emergency* position quickly and left there until the train stops.

Q. 41. Should this position be used at any other time?

A. Yes; this position should be used in case of an emergency application of the brakes from an unknown cause, such as the

opening of a conductor's valve, bursted hose, etc., in order to prevent loss of main reservoir pressure and to insure a full application of the brakes and the handle should be left there until signal to release is given.

Q. 42. Why should *emergency* position be used as explained in the last answer instead of *lap* position?

A. To insure the brakes remaining applied under all circumstances.

Q. 43. Explain the flow of air through the automatic brake valve when in *emergency* position.

A. A large and direct opening is made from the brake pipe to the atmosphere, through the rotary valve, causing a quick and heavy reduction of brake pipe pressure. At the same time the air in the equalizing reservoir escapes to the atmosphere through ports in the rotary valve. Connection is made from air at main reservoir pressure above the rotary valve through a restricted port in the rotary valve to the application cylinder pipe leading to the application cylinder of the distributing valve. This port is known as the blow-down timing port, and assists in building up and regulating application cylinder pressure during emergency application.

S-6 INDEPENDENT BRAKE VALVE.

Q. How many positions has the S-6 Brake Valve?

A. Five.

Q. 45. Name the positions beginning at the left.

A. *Release, Running Lap, Slow-Application* and *Quick-Application* (see Fig. 24).

Q. 46. Name and describe the purpose of the pipe connections to the S-6 Brake Valve.

A. (a) Reducing Valve Pipe. This is the only source of air supply to the valve and connects the reducing valve to the chamber above the rotary valve, and through the rotary valve when the independent brake valve handle is in either *application* position, to the application cylinder and chamber of the distributing valve and also through the warning port to the atmosphere when the handle is in *release* position.

(b) Distributing Valve Release Pipe *to the distributing valve.* Connects the application chamber of the distributing valve to the underside of the independent brake valve. When the brake valve handle is in *running* position, this pipe is connected through ports in the seat and cavities in the rotary valve to the automatic brake valve.

(c) Distributing Valve Release Pipe to *the automatic brake valve.* This pipe connects the underside of

the rotary valve of the independent brake valve to the underside of the rotary valve of the automatic brake valve. With both brake valve handles in *running* position, free passage is made from the application chamber of the distributing valve to the atmosphere through this pipe.

(d) Application Cylinder Pipe. Connects the application cylinder to the underside of the rotary valve of the independent brake valve. When the handle is in either *application* position air from above the rotary valve flows through this pipe to the application cylinder and chamber of the distributing valve. When the handle is in *release* position this pipe is connected to the atmosphere through ports in the rotary valve and seat.

. 47. When is *release* position used?

. Whenever it may be necessary to release the brake when utomatic brake valve handle is not in *running* position.

. 48. Explain the flow of air through the independent brake when in *release* position.

. Air from the application cylinder of the distributing valve direct through the application cylinder pipe and independent e valve to the atmosphere. At the same time air from above otary valve (reducing valve pressure) flows through the ro- valve and warning port to the atmosphere.

. 49. When is *running* position used?

. When running along the road and to release the locomo- brake after an independent application, the automatic brake handle being in running position.

. 50. Explain the flow of air through the independent brake when in *running* position. (Automatic brake valve handle *unning* position.)

. Air from the application chamber of the distributing valve through the distributing valve release pipe and independent e valve, then through the automatic brake valve to the atmos- e.

. 51. When is *lap* position used?

. When holding the engine and tender brake applied after an pendent application.

. 52. Is there any flow of air through the independent e valve when in *lap* position?

. No.

. 53. When is *slow-application* position used?

. When it is desired to apply the locomotive brakes lightly radually.

Q. 54. Explain the flow of air through the indepe brake valve when in *slow-application* position.

A. Air flows from the chamber above the rotary valve th the restricted service port and application cylinder pipe int application cylinder and chamber of the distributing valve.

Q. 55. When is *quick-application* position used?

A. When it is desired to apply the locomotive brakes pron

Q. 56. Explain the flow of air through the independent l valve when in quick-application position.

A. Air flows from above the rotary valve through a full service port in the rotary valve and the application cylinder to the application cylinder and chamber of the distributing v

Q. 57. What prevents the independent brake valve h from remaining in *release* position or in *quick-application* pos unless held there?

A. A return spring.

Q. 58. To what position does the return spring move brake valve handle from *release* position?

A. To *running* position.

Q. 59. Why is this necessary?

A. To prevent the possibility of the independent br valve handle being left in *release* position, which would cause engine and tender brakes to release whenever an automatic plication was made.

Q. 60. To what position does the return spring move brake valve handle from *quick-application* position?

A. To *slow-application* position.

Q. 61. Why is the spring used for this purpose?

A. To act as a stop, guarding against a quick applicatio when only a slow application is intended, and to return the handl from *quick* to *slow-application* position.

Q. 62. Why is this latter necessary?

A. In order to limit the flow of air to the application cylinde when the independent brake is to be left applied.

NO. 6 DISTRIBUTING VALVE WITH PLAIN CYLINDER CAP.

Q. 63. What controls the brake cylinder pressure on th locomotive with No. 6 ET equipment?

A. The distributing valve.

Q. 64. How does it do this?

A. It permits air to flow from the main reservoirs to th brake cylinders when applying the brake, from the cylinders t

mosphere when releasing the brake, and automatically main-
he pressure against leakage, keeping it constant, when hold-
brake applied.

65. Is the amount of air flowing from the main reservoirs brake cylinders limited by the distributing valve?

Yes; the distributing valve acts as a reducing valve in ing air from the main reservoirs to the locomotive brake ers.

66. Facing the distributing valve, name the two pipes right hand side of the reservoir and state to what each one ts (see Fig. 5).

(a) The upper pipe on the right is the brake cylinder pipe. It connects the distributing valve to all the brake cylinders on the engine and tender.

(b) The lower pipe on the right is the brake pipe branch pipe. It connects the distributing valve to the brake pipe.

67. Name the three pipes on the left hand side of the res- and state to what each one connects (see Fig. 5).

(a) The upper pipe on the left is the supply pipe. It connects the distributing valve to the main reservoir pipe.

(b) The intermediate pipe is the application cylinder pipe. It connects the distributing valve to both the automatic and independent brake valves.

(c) The lower pipe is the release pipe, which connects the distributing valve to the independent brake valve and through it to the automatic brake valve.

68. How many chambers has the distributing valve res-

Two.

69. Name them.

Pressure chamber and application chamber (see Fig. 4).

70. How many pistons has the distributing valve?

Two.

71. Name them.

Application piston 10 and equalizing piston 26.

72. How many slide valves has the distributing valve?

Four.

73. Name them.

Application valve 5, exhaust valve 16, equalizing valve graduating valve 28.

74. What valves are operated by the application piston?

The application valve and exhaust valve.

75. What valves are operated by the equalizing piston?

A. The equalizing valve and graduating valve.

Q. 76. With the brake released what pressures are present in the distributing valve?

A. Main reservoir pressure, brake pipe pressure and atmospheric pressure.

Q. 77. In what portion of the distributing valve is main reservoir pressure?

A. In chamber *a*, Fig. 7, above the application valve.

Q. 78. In what portion of the distributing valve is brake pipe pressure?

A. In the pressure chamber and in the chamber above the equalizing valve and graduating valve.

Q. 79. In what portion of the distributing valve is atmospheric pressure?

A. In chamber *b* above the exhaust valve 16 and on the right hand side of the application piston 10; in chamber *g* on the left hand side of the application piston (called the application cylinder) and in the application chamber and the ports and cavities connecting to them.

Q. 80. How is chamber *a* charged with air at main reservoir pressure?

A. Through the branch pipe leading from the main reservoir pipe to the connection marked *MR* on the distributing valve reservoir.

Q. 81. Describe the operation of the distributing valve parts when an independent application of the brake is made.

A. Air is admitted to the application cylinder *g* and the application chamber from the reducing valve through the independent brake valve and the intermediate pipe on the left (application chamber pipe). This pressure will force the application piston 10 to the right, Fig. 12, lapping exhaust ports *d* and *e* with exhaust valve 16, and compressing graduating spring 20 and open supply port *b* through the application valve 5 to the brake cylinder chamber *b*, which is connected to the right of the application piston, obtaining a brake cylinder pressure slightly exceeding that in the application cylinder, when it and the graduating spring 20 then moves the piston 10 and the application valve 5 back to lap position Fig. 13. The exhaust valve 16 will remain lapped, as there is sufficient clearance between the shoulders of the piston stem and the exhaust valve to permit the application valve to return to lap without moving the exhaust valve. At the same time cavity *s* in the equalizing valve 31 registers with ports *h* and *l* in the seat, thus connecting the application cylinder port *h* to the safety valve. *The equalizing piston and slide valve do not move during an independent application of the brake.*

Q. 82. Describe the operation of the distributing valve parts when an independent release of the brake is made.

A. By a proper movement of the independent brake handle air from the application cylinder *g* and the application chamber is allowed to flow to the atmosphere, which reduces the pressure in chamber *g* below that in chamber *b*, causing the application piston 10 to move to the left, carrying with it application valve 5 and exhaust valve 16 until ports *d* and *e* are open past and through exhaust valve 16, Fig. 7, permitting the air in the brake cylinders to flow through port *c* into chamber *b*, thence through ports *d* and *e* to the exhaust and atmosphere. *The equalizing piston and its valves do not move during an independent release of the brakes.*

Q. 83. How is the pressure chamber charged with air at brake pipe pressure?

A. Through the branch pipe leading from the brake pipe to the connection marked BP on the distributing valve reservoir, Fig. 5, leading into chamber *p*, Fig. 7, then through feed groove *v* around top of piston 26 into the chamber above the equalizing valve 31 and through port *o* to the pressure chamber until the pressure on both sides of the piston are equal.

Q. 84. From where do the application cylinder and chamber receive their air?

A. From the *reducing valve* through the independent brake valve during independent applications and from the *pressure chamber* during automatic service applications.

Q. 85. Describe the operation of the distributing valve parts when an automatic service application of the brake is made.

A. The brake pipe pressure in chamber *p* on the brake pipe side of equalizing piston 26 being reduced below that in the pressure chamber on the opposite side of the piston results in piston 26 being moved toward the right. The first movement of piston 26 closes the feed groove *v*, and at the same time moves the graduating valve 28 until it opens the service port *z* in the equalizing valve, and connects the safety valve ports *r* and *s* in equalizing valve through cavity *t* in the graduating valve. As the piston continues its movement, the "spider" on the end of the piston stem engages the slide valve 31, which is then moved to the right until the supply port *z* in the equalizing valve registers with the application cylinder port *h* and through cavity *n* in the equalizing valve with application chamber port *w* in the seat. This permits the air in the pressure chamber to expand into the application cylinder. At the same time the safety valve is connected to the application cylinder and application chamber by registering ports *r* and *s* in the equalizing valve with ports *h* and *l* in the seat and through the cavity *t* in the graduating valve, Fig. 8. The amount

of pressure obtained in the application cylinder and chamber depends upon the brake pipe reduction made. When the pressure in the pressure chamber is slightly reduced below that in the brake pipe, the piston and the graduating valve are forced to the left until the collar on the piston stem comes in contact with the equalizing valve. This position is known as "service lap," Fig. 9. In this position the graduating valve has lapped port *z* between the pressure chamber and the application cylinder and has also lapped the safety valve port *l*. The air that expanded into the application cylinder and chamber will force the application piston 10 to the right, lapping the exhaust ports *d* and *e* with the exhaust valve 16, compressing graduating spring 20 and opening the supply port *b* through the application valve 5 to brake cylinder, as explained in answer to question 81.

Q. 86. Describe the operation of the distributing valve when the brake is released with the independent brake valve, after an automatic application.

A. With the independent brake valve handle in *release* position, air in application cylinder *g* and the application chamber flows direct to the atmosphere through the application cylinder pipe. This reduces the pressure in chamber *g* below that in chamber *b*, causing supply valve piston 10 to move to the left, carrying with it application valve 5 and exhaust valve 16 to *release* position, Fig. 14, thus releasing the brake.

Q. 87. Do the equalizing parts of the distributing valve operate at this time?

A. No.

Q. 88. Describe the operation of the distributing valve parts when making an automatic release of the brakes.

A. The brake pipe pressure in chamber *p* on the brake pipe side of equalizing piston 26 being increased above that in the pressure chamber on the opposite side of the piston results in the piston being moved toward the left, carrying with it graduating valve 28 and equalizing valve 31 to release position. In this position cavity *k* in equalizing valve 31 registers with ports *w*, *h* and *i* in the seat. This allows air from the application cylinder *g* and the application chamber to flow through the ports mentioned to the distributing valve release pipe IV and to the atmosphere. At the same time the reduction of pressure in chamber *g* below that in chamber *b* causes the supply piston 10 to move to the left, carrying with it exhaust valve 16 to release position, Fig. 7, thus releasing the brake as described in answer to question 82.

Q. 89. Describe the operation of the distributing valve parts when an automatic emergency application of the brake is made.

A. Brake pipe pressure in chamber *p* on the brake pipe side of equalizing piston 26 is suddenly reduced below that in the pressure chamber on the opposite side of the piston. The considerable dif

erence in pressure thus created on the two sides of equalizing iston 26 is sufficient to move it to its extreme position to the ight, compressing graduating spring 46, Fig. 10. In this position ort *h* is open directly to the chamber above equalizing valve 31, ast the end of the valve, so that air from the pressure chamber ows through port "o," through the chamber above equalizing alve to port "h" and the application cylinder *g*. The application hamber port *w* is blanked by the equalizing valve 31 and the safety alve port *l* is connected through port *r* and restricted port *q* in alve 31 to port *h* of the application cylinder. The air that ex-anded into the application cylinder from the pressure chamber vill force the application piston 10 to the right opening the ap-lication valve 5 as in service application and obtaining cylinder ressure equal to that in the application cylinder, when the appli-ation valve will lap, Fig. 11.

Q. 90. What brake cylinder pressure is obtained from a full utomatic service application of the brake from a 70 pound brake ipe pressure? (Safety valve set at 68 pounds.)

A. Fifty pounds.

Q. 91. What brake cylinder pressure is obtained with an utomatic emergency application from a 70 pound brake pipe pres-ure? (Safety valve set at 68 pounds.)

A. About seventy pounds.

Q. 92. How is the difference between service and emergency rake cylinder pressure obtained?

A. With all automatic service applications the pressure cham-er is connected to both the application chamber and application ylinder, the relative volumes of which are such that the air in he pressure chamber at 70 pounds pressure will equalize with he combined volumes of the application chamber and cylinder at 0 pounds pressure, which is, therefore, the maximum which can e obtained with an automatic service application. With all emer-ency applications the pressure chamber is not connected to the pplication chamber, but to the application cylinder only. The ir in the pressure chamber then expands into the application cyl-nder, equalizing at about 65 pounds from a 70 pound brake pipe ressure. During emergency application air is admitted through a mall port in the automatic brake valve (called the blow-down iming port) and the application cylinder pipe to the application ylinder. The size of the blow-down timing port in the brake alve is proportioned to the restricted port in the equalizing valve eading to the safety valve so as to give the proper time of blow-own of brake cylinder pressure.

Q. 93. Will piston travel or brake cylinder leakage affect he brake cylinder pressure on the engine and tender?

A. No.

Q. 94. How is a predetermined brake cylinder pressure obtained and maintained in the engine and tender brake cylinder regardless of piston travel and leakage?

A. As the brake cylinders receive their air from the main reservoirs they have practically an unlimited supply to draw from. The distributing valve and its reservoir volumes are constant, so that with a given brake pipe reduction a given application cylinder pressure will be obtained (about 2½ pounds appliication cylinder and chamber pressure for every pound brake pipe reduction). The air that is admitted to the application cylinder forces the application piston and its valves to the right, Fig. 8, closing the exhaust ports and allowing air from the main reservoir branch pipe to flow to the brake cylinders until brake cylinder pressure becomes equal to that in the application cylinder, regardless of what the piston travel is, the number of cylinders or the amount of leakage. When this pressure has been obtained, if brake cylinder leakage exists, the drop in cylinder pressure will reduce the pressure in chamber *b* on the right of piston 10 below that in application cylinder *g* on the opposite side of the piston. This will cause application piston 10 to again move to the right opening application valve 5 and allowing air to flow from the main reservoirs to the brake cylinders until the brake cylinder pressure again equalizes with that in the aplication cylinder, when the application piston 10 and supply valve 5 will move to lap position. Fig. 9. This action will continue indefinitely until the brakes are released.

SAFETY VALVE.

Q. 95. What is the purpose of the safety valve? No. 34. Fig. 4.

A. To prevent abnormal brake cylinder pressure and to act as a high speed reducing valve for the locomotive brake cylinders.

Q. 96. To what is the safety valve connected?

A. To the application cylinder.

Q. 97. When is the safety valve connected to the application cylinder?

A. At all times except in automatic service lap position of the distributing valve.

Q. 98. For what pressure is the safety valve adjusted?

A. Sixty-eight pounds, except when the locomotive is transported light over the road, when it is ordinarily adjusted to 35 pounds.

Q. 99. How does the safety valve act as a high speed reducing valve?

A. When an automatic service application is made and the equalizing valve and graduating valve are in service position, the safety valve is connected to the application cylinder and chamber

through large ports, and will therefore prevent the brake cylinder pressure rising above that for which the safety valve is adjusted. During emergency application the connection between the application cylinder and the safety valve is smaller than during service application, so that the flow of air from the application cylinder to the safety valve is restricted, which, in conjunction with the blow-down timing port, regulates the time of blow-down of brake cylinder pressure.

QUICK-ACTION CYLINDER CAP.

Q. 100. Where is the quick-action cylinder cap located?

A. On the brake pipe end of the distributing valve (see Fig. 16), replacing the plain cylinder cap 23, Fig. 11.

Q. 101. What is its purpose?

A. To vent brake pipe air into the locomotive brake cylinders when an emergency position of the brake is made.

Q. 102. Does it operate at any other time?

A. No.

Q. 103. Why is this cap used?

A. To assist in obtaining an emergency application of the brakes in the train when double heading.

Q. 104. Then the quick-action cylinder cap performs the same function in actuating quick-action as a quick-action triple valve on the tender with other types of locomotive brakes?

A. Yes.

Q. 105. Does the air flowing to the brake cylinders through the quick-action cylinder cap increase the brake cylinder pressure as is the case with the quick-action triple valve?

A. No; as the brake cylinder pressure is governed by the pressure in the application cylinder of the distributing valve.

Q. 106. What advantage has this device over quick-action triple valves on the tender?

A. It is less liable to cause undesired quick-action than a triple valve, as it is much less sensitive.

Q. 107. Why is it possible to use a valve less sensitive to quick-action than a triple valve?

A. As the quick-action cylinder cap is always located close to the automatic brake valve being operated; when an emergency application is made the quick-action cylinder cap is subjected to a more rapid brake pipe reduction than is the case with a triple valve located at a considerable distance from the brake valve, and consequently need not be so sensitive in order to accomplish its purpose.

Q. 108. When the distributing valve is provided with a quick-action cap, how should the automatic brake valve handle be operated?

A. Exactly the same as when the distributing valve has plain cylinder cap.

Q. 109. Describe the operation of the quick-action cylinder cap.

A. When the automatic brake valve handle is moved to emergency position, equalizing piston 26, Fig. 15, moves to the right, which movement causes the knob on the piston to strike the graduating stem 50, causing it to compress graduating spring 55, moving emergency valve 48 so as to open port *j*. Brake pipe pressure in chamber *p* then flows to chamber X, unseats check valve 53 and passes to the brake cylinders through port *m* in the cap and distributing valve body.

Q. 110. What duty does the check valve 53 perform?

A. When the brake cylinder and brake pipe pressures become equal, the check valve is forced to its seat by spring 54, thus preventing air in the brake cylinders from flowing back into the brake pipe.

Q. 111. What takes place when a release is made?

A. Piston 26 is moved back to *release* position, spring 55 forces graduating stem 50 and emergency valve 48 back to the position shown in Fig. 15.

Q. 112. Are there any other differences in the operation of the distributing valve having this cap?

A. No; in all other respects the operation of the distributing valve is the same as described under the heading "No. 6 Distributing Valve With Plain Cylinder Cap."

THE B-6 FEED VALVE.

Q. 113. How does the B-6 feed valve differ from that used with former automatic brake equipments?

A. The B-6 feed valve is made adustable for either high or low brake pipe pressure and can easily be changed from one to the other. Otherwise, except for improvements in the mechanical design of the valve, it is the same as that used with former equipments.

Q. 114. How is the change in adjustment accomplished?

A. The adjusting nut is provided with a hand wheel, having a lug, working between two adjustable stops on the body of the valve. These stops are adjusted for the high and low brake pipe pressure which it is desired to carry and the change of pressure from one to the other is accomplished by simply turning the hand wheel from one stop to the other.

Q. 115. Where is the feed valve located?

A. On a bracket interposed between the main reservoir and feed valve pipes.

Q. 116. Why is this bracket used?

A. To support the valve and permit it to be easily removed and replaced.

Q. 117. What are the essential working parts of the feed valve?

A. The supply valve and actuating piston, the regulating valve, diaphragm, regulating spring and supply valve piston spring.

Q. 118. Explain the general arrangement of the feed valve?

A. The feed valve consists of two sets of parts designated as the supply parts and the regulating parts. The supply parts, which control the flow of air through the valve consist of the supply valve 9, Fig. 29, and its spring 10, supply valve piston 8 and supply valve piston spring 6. The regulating parts consist of the regulating valve 12, regulating valve spring 13, diaphragm 14, diaphragm spindle 16 and regulating spring 17.

Q. 119. What is the normal position of this valve?

A. Closed, as shown in Fig. 29.

Q. 120. Explain the duty of the various operative parts?

A. Supply valve 9 is for the purpose of opening and closing port *c* in its seat. Piston 8 is for the purpose of moving the supply valve 9. Spring 6 is for the purpose of moving the piston and closing the supply valve when the pressures have equalized on both sides of piston 8.

Q. 121. What are the duties of the regulating parts?

A. To control the action of the supply valve piston and supply valve when opening and closing the supply port *c* in the seat.

Q. 122. Explain the operation and flow of air through the feed valve when open.

A. By referring to Fig. 29, which is a diagrammatic view of the valve in its closed position, air entering through port *a* from the main reservoir is free to pass into the supply valve chamber "B" causing the supply valve piston 8 to be moved to the left, compressing piston spring 6, as shown in Fig. 30, by which movement the supply valve 9 uncovers port *c* in the valve seat, thereby permitting air to pass directly through ports *c* and *dd* to the feed valve pipe at the same time air is passing by the supply valve piston 8, which is not an airtight fit, to chamber *G*, thence through port *hH* by the regulating valve 12, and through port *K* to diaphragm chamber *L* and on through ports *edd* to the feed valve pipe.

Q. 123. What will cause a valve to close and stop the flow of air from the main reservoir to feed valve pipe?

A. When the pressure in the feed valve pipe and chamber *L* slightly exceeds the tension of the regulating spring 17, the

diaphragm 14 will yield and allow regulating valve 12 to move to its seat, closing port *K*, and preventing the flow of air from chamber *G*. As the air continues to leak by supply valve piston 8, it will equalize the pressure on both sides of the piston and allow supply valve piston spring 6, which was previously compressed, to react and move the piston and supply valve to the position shown in Fig. 30 closing port *c* in the supply valve seat.

Q. 124. With the feed valve closed, and the pressure equalized on each side of the supply valve piston, what will cause it to open to supply the feed valve pipe when the pressure has been reduced?

A. Diaphragm chamber *L* is always in direct communication with the feed valve pipe; therefore, any reduction in feed valve pipe pressure reduces the pressure in chamber *L*, which allows the tension of the regulating spring to overcome the diminished air pressure in chamber *L*, and force the diaphragm 14 to the left. This unseats the regulating valve 12, permitting the accumulated air pressure in chamber *G* to escape to the feed valve pipe through ports *hH* and through port *K*, diaphragm chamber *L* and ports *cdd*. The equilibrium of pressure on the two sides of the supply valve piston now being destroyed, the main reservoir pressure which is present in supply valve chamber *B* forces the supply valve piston 8 to the left, which moves the supply valve 9 with it, opening port *c* and again permitting the air to pass to the feed valve pipe until the pressure has been restored to the proper amount.

Q. 125. The supply valve then maintains practically a wide open port until maximum pressure is obtained?

A. Yes; and when maximum pressure is obtained, the supply valve closes the supply port quickly.

C-6 REDUCING VALVE.

Q. 126. What is the difference in the construction and operation of the C-6 reducing valve, Fig. 31, and the B-6 feed valve?

A. The only difference between it and the B-6 feed valve just described is in the convenience of adjustment, the C-6 reducing valve having the ordinary adjusting nut and cap nut used on former types of feed valves instead of the hand adjusting wheel 22 used with the B-6 feed valve shown in Fig. 30. It is called a "Reducing Valve" simply to distinguish it from the B-6 feed valve.

SF-4 PUMP GOVERNOR.

Q. 127. Where is the SF-4 pump governor located?

A. In the pipe supplying steam to the air compressor.

Q. 128. Explain the general arrangement of the pump governor.

A. It consists of a standard steam portion, with Siamese fitting, and two diaphragm portions, as illustrated in Fig. 32.

Q. 129. How are these diaphragm portions designated?

A. That having two pipe connections the *excess pressure head* and that having a single pipe connection the *maximum pressure head.*

Q. 130. What are the pipe connections of the governor?

A. *B*, to the boiler; *P*, the air compressor; *MR*, main reservoir; *AB*, the automatic brake valve; *FVP*, the feed valve pipe; *W*, waste pipe.

Q. 131. When does the excess pressure head govern the operation of the air compressor?

A. At all times when the automatic brake valve handle is in *release, running* or *holding* positions.

Q. 132. When does the maximum pressure head govern the operation of the air compressor?

A. During the time the automatic brake valve handle is in *lap, service,* or *emergency* positions.

Q. 133. Explain the flow of steam through the governor.

A. Steam enters at *B*, passes by steam valve 5 to the connection *P*, and on to the air compressor.

Q. 134. With the automatic brake valve handle in *release, running* or *holding* position, what pressures act on the diaphragm 28 of the excess pressure head?

A. Air from the main reservoir flows through the automatic brake valve to the connection marked *ABV*, to chamber *d* under diaphragm 28. Air from the feed valve pipe enters at connection *FVP* and flows to chamber *f* above diaphragm 28. In addition to this, regulating spring 27 also acts upon the upper side of the diaphragm.

Q. 135. What is the adjustment of this spring?

A. About 20 pounds.

Q. 136. What total pressure is, therefore acting upon the upper side of diaphragm 28?

A. Whatever pressure the feed valve pipe may have, plus the tension of the regulating spring 27.

Q. 137. What pressure in chamber *d* below diaphragm 28 will be required to overcome that acting on the upper side of the diaphragm?

A. A pressure slightly higher than that in the feed valve pipe plus the spring pressure. For example, with a pressure of 70 pounds in the feed valve pipe, about 90 pounds pressure below diaphragm 28 will be required to overcome that acting upon the upper side of the diaphragm.

Q. 138. How does a variation in feed valve adjustment affect the governor?

A. When the feed valve adjustment is changed from one amount to another as where the locomotive is used alternately in high speed brake and ordinary service, the excess pressure head of the governor automatically changes the main reservoir pressure so as to maintain the same excess pressure (20 pounds).

Q. 139. Why is this of advantage?

A. Because it insures that the main reservoir pressure will always be 20 pounds higher than that of the feed valve pipe.

Q. 140. Explain the operation of the governor when main reservoir pressure in chamber *d* below diaphragm 28 becomes slightly higher than that acting on top of the diaphragm.

A. Diaphragm 28 will rise, unseat its pin valve 33, and allow air to flow to chamber b above the governor piston 6, forcing the latter down, compressing piston spring 9 and restricting the flow of steam past steam valve 5 to a point where the compressor will just supply the leakage in brake system.

Q. 141. How long will the flow of steam through the governor be restricted in this manner?

A. Until main reservoir pressure in diaphragm chamber *d* becomes reduced slightly below the combined spring and air pressure in chamber *f* above the diaphragm, which will then force diaphragm down, seating its pin valve.

Q. 142. How does this effect the flow of steam through the governor?

A. As chamber *b* is always open to the atmosphere through the small vent port *c*, the air pressure in chamber *b* above the governor piston 6 will then escape to the atmosphere and allow piston spring 9 and the steam pressure below valve 5 to raise it and the governor piston 6 to the position shown. Fig. 32.

Q. 143. With the automatic brake valve handle in *release*, *running* or *holding* position, does the maximum pressure head operate?

A. No; as during this time its diaphragm pin valve remains seated.

Q. 144. To what is chamber *a* in the maximum pressure head always connected?

A. To the main reservoir.

Q. 145. When does the maximum pressure head of the governor control the operation of the compressor?

A. When the automatic brake valve handle is in *lap*, *service* or *emergency* position, or when the main reservoir cut-out cock is closed.

Q. 146. With the automatic brake valve handle in *lap*, *service* r *emergency* position, or when the main reservoir cut-out cock is losed, what pressures act on the diaphragm 20 of the maximum ressure head?

A. Main reservoir pressure which flows directly to chamber on the underside of diaphragm 20 and the pressure of regulating pring 19 on the upper side.

Q. 147. What is the adjustment of spring 19?

A. Spring 19 is adjusted to the maximum pressure which is esired in the main reservoirs.

Q. 148. Explain the operation of the governor when main eservoir pressure in chamber "a" exceeds the tension of spring 19.

A. When main reservoir pressure in chamber *a* slightly exeeds the adjustment of spring 19, diaphragm 20 will rise, unseat s pin valve 33, and allow air to flow into chamber *b* above the overnor piston, forcing it down, compressing its spring 9 and estricting the flow of steam past steam valve 5 to a point where he compressor will just supply the leakage in brake system.

Q. 149. How long will the flow of steam through the govrnor be restricted in this manner?

A. When main reservoir pressure in chamber *a* becomes lightly reduced, the spring 19 forces diaphragm 20 down, seatng its pin valve. As chamber *b* is always open to the atmosphere through the small vent port *c*, the pressure in chamber *b* bove the governor piston 6 will then escape to the atmosphere nd allow the piston spring 9 and steam pressure below valve 5 o raise the valve and governor piston to the position shown. Fig. 32.

Q. 150. Is the maximum pressure head of the governor in ny way controlled by the automatic brake valve?

A. No; as the chamber *a* below the diaphragm is in no way onnected to the brake valve.

Q. 151. With the automatic brake valve handle in *lap*, *ervice* or *emergency* positions or when the main reservoir cutut cock is closed why does not the excess pressure head operate nstead of the maximum pressure head?

A. Because under these conditions, communication from the ain reservoir to chamber *d* is cut off by the brake valve and t the same time connection from the feed valve pipe to chamber above diaphragm 28 still remains open, so that the combined r and spring pressure on top of the diaphragm holds the pin alve to its seat, rendering the excess pressure head inoperative.

Q. 152. Under ordinary running conditions, why is only a oderate excess pressure desirable?

A. Because most of the time the automatic brake valve handle in *running* position, (keeping the brakes charged) but little

excess pressure is needed and the governor regulates the main reservoir pressure to about 20 pounds above the brake pipe pressure, thus relieving the compressor of unnecessary work.

Q. 153. When an application of the brakes is made, why is the higher excess pressure of advantage?

A. To insure a prompt release of the brakes and recharge of the system.

DEAD ENGINE FIXTURES.

Q. 154. What are the parts composing the dead engine fixtures.

A. A ⅜-inch pipe connecting the brake pipe and main reservoir pipe, a combined strainer and check valve with choke fitting, and a ⅜-inch cut-out cock.

Q. 155. What is the purpose of the "Dead Engine" feature of the ET Equipment?

A. To enable the compressor on a "live" engine to charge the main reservoir on a "dead" engine, so that the brake on the dead engine may be operated with the other brakes in the train.

Q. 156. How is this done?

A. Air from the main reservoir of the live engine passes through the brake pipe and dead engine fixtures to the main reservoirs of the dead engine.

Q. 157. When is this apparatus used?

A. Only when the air compressor on the locomotive is inoperative.

Q. 158. Should the cut-out cock always be closed except when the compressor is inoperative?

A. Yes.

Q. 159. Describe the flow of air through the combined strainer and check valve. Fig. 33.

A. With the cut-out open, air from the brake pipe enters at *BP*, passes through the curled hair strainer, lifts check valve 4, held to its seat by a strong spring 2, passes through the choke bushing, and out at *MR* to the main reservoir pipe.

Q. 160. Why is the "strong" spring 2 used in this valve?

A. This spring over the check valve insures the valve seating and keeps the main reservoir pressure somewhat lower than the brake pipe pressure, yet assures ample pressure to operate the locomotive brakes.

Q. 161. What is the object of the choke fitting?

A. It prevents a sudden drop in brake pipe pressure and the application of the brakes in the train, as might otherwise occur with uncharged main reservoirs cut into a charged brake

pipe or if for any reason the main reservoir pressure was lower than the brake pipe pressure.

Q. 162. How can the maximum brake cylinder pressure be regulated on a dead engine?

A. By the adjustment of the safety valve on the distributing valve.

Q. 163. Can the brake on a dead engine be controlled with the independent brake valve the same as on a live engine?

A. Yes, if it becomes necessary.

Q. 164. When the dead-engine feature is used, in what position should the automatic and independent brake valve handles be carried?

A. *Running* position.

Q. 165. What should be the position of the double heading cock?

A. Closed.

Q. 166. Is it sometimes desirable to keep the braking power of a locomotive below the standard?

A. Yes; when there is no water in the boiler.

Q. 167. How is this done?

A. By adjusting the safety valve on the distributing valve to the maximum brake cylinder pressure which is desired in the locomotive brake cylinders.

AIR GAGES.

Q. 168. How many and what type of gages are used in connection with the ET Equipment?

A. Two duplex gages, designated—No. 1, Large Duplex Air Gage; No. 2, Small Duplex Air Gage. (See Figs. 1-A and 1-B.)

Q. 169. What pressures are indicated by gage No. 1?

A. Red Hand, Main Reservoir Pressure; Black Hand, Equalizing Reservoir Pressure.

Q. 170. What pressures are indicated by gage No. 2?

A. Red Hand, Brake Cylinder Pressure; Black Hand, Brake Pipe Pressure.

Q. 171. Which gage hand shows the amount of reduction being made during a service application of the brakes?

A. Black Hand, Gage No. 1.

Q. 172. Why, then, is the black hand of gage No. 2 necessary?

A. To show brake pipe pressure when engine is second in double-heading or a helper.

Q. 173. What pressure is indicated by the red hand of gage No. 2 when operating the automatic or independent brake valve?

A. Brake cylinder pressure.

CUT-OUT COCKS.

Q. 174. What provision is made for cutting off the reservoirs from the brake system?

A. The main reservoir cut-out cock in the main res pipe.

Q. 175. What takes place when this cock is closed?

A. The flow of air from the main reservoirs is cut off the air in the brake system back of it is exhausted to atmosphere.

Q. 176. When this cock is closed can air flow from main reservoirs to any part of the system?

A. Yes; to the maximum pressure head of the pump gove

Q. 177. Why is this necessary?

A. To provide for the automatic control of the compr when the cut-out cock is temporarily closed.

Q. 178. What provision is made for cutting out the d brake?

A. A ¾-inch cut-out cock located in the pipe leading the distributing valve to the driver brake cylinders.

Q. 179. What provision is made for cutting out the te brake?

A. A ¾-inch cut-out cock located in the pipe between the tributing valve and the hose connection leading to the te brake cylinder.

Q. 180. What difference is there between this cock and ¾-inch cocks generally used?

A. It has a choke fitting.

Q. 181. Why is this choke fitting used?

A. To prevent a loss of driver and truck brake cyli pressure in the event of a hose or tender brake cylinder bursting.

Q. 182. Is there another cock with choke fitting someti used in connection with this apparatus?

A. Yes; when a truck brake is used a ½-inch cock is loc in the pipe leading from the distributing valve to the truck b cylinder with choke fitting.

Q. 183. For what purpose is the ¾-inch cut-out cock in main reservoir supply pipe to the distributing valve?

A. To cut off the supply of air from the main reservoir the distributing valve to permit of inspection and repairs.

Q. 184. For what purpose is the one-inch double heading underneath the brake valve?

A. To cut off the flow from the automatic brake valv the brake pipe or vice versa.

. 185. What is the purpose of the brake pipe air strainer.

. To prevent foreign matter entering the distributing valve, i might seriously interfere with its proper operation.

AIR SIGNAL SYSTEM.

. 186. From what source is the supply of air to the signal m obtained with the ET Equipment?

. From the reducing valve pipe between the reducing valve he independent brake valve, as shown in Figs. 1-A and 1-B.

. 187. Why is this supply taken from the reducing valve

. That the one reducing valve may govern the pressure for the independent brake valve and the signal system.

. 188. What device is interposed between the reducing valve and the air signal pipe?

. A combined strainer and check valve.

. 189. Why is the strainer necessary?

. To protect the check valve and signal system from gn matter.

. 190. Why is the check valve employed?

. To prevent a back flow of air from the signal pipe to educing valve pipe.

. 191. In what way does this combined strainer and check differ from that used with the dead engine fixtures?

. Only in the tension of the check valve spring.

ENERAL OPERATION OF THE NO. 6 EQUIPMENT.

OTE.—Details of construction and operation of the various es will be found under their respective headings.

. 192. What is the proper position of the brake valve les and cut-out cocks before starting the compressor?

. The automatic and independent brake valve handles in *ing* position all cut-out cocks must be open, except the ⅜-inch ut cock in the dead engine connection and the angle and cocks at the front and rear end of the locomotive.

. 193. Explain the charging of the ET Equipment.

. While the compressor is operating, the main reservoir ure continues to rise until it reaches the point for which the nor is adjusted. The governor then automatically stops the ressor. From the main reservoirs air flows through the reservoir pipe to the chamber above the application valve ie distributing valve. It also flows to the feed valve which es the pressure of the air to that carried in the brake pipe. air at this reduced pressure flows through the automatic

brake valve to the brake pipe and thence through the branch and distributing valve to the pressure chamber charging i to brake pipe pressure. Air also flows from the main reser through the reducing valve to the independent brake valve air signal system.

Q. 194. What must be done to make an automatic se application of the brake?

A. Move the automatic brake valve handle to *service* pos

Q. 195. How does this apply the brake?

A. It starts a reduction of brake pipe pressure which c the distributing valve to operate so as to allow air to from the main reservoirs into the brake cylinders.

Q. 196. How is the application of the brake limited to desired cylinder pressure?

A. By returning the automatic brake valve handle to position.

Q. 197. What must be done to make an emergency apr tion of the brakes?

A. Move the automatic brake valve handle to *emerg* position.

Q. 198. How does an emergency application of the b differ from a service application?

A. Brake pipe reduction takes place more rapidly, b cylinder pressure rises more quickly and a higher brake cyli pressure is obtained than in service applications.

Q. 199. In what position should the automatic brake v handle be placed to release the locomotive brake?

A. *Running* position.

Q. 200. Is there any position besides *running* position which the locomotive brake can be released by the use of automatic brake valve?

A. No.

Q. 201. Can the locomotive brake be applied otherwise t by using the automatic brake valve?

A. Yes. By the independent brake valve.

Q. 202. In what position should the independent brake v handle be placed to apply the locomotive brakes?

A. *Application* position.

Q. 203. How does this apply the brake?

A. It allows air to flow from the reducing valve through independent brake valve to the distributing valve, causing it operate and allow air to flow from the main reservoirs into brake cylinders at a reduced pressure.

Q. 204. Is the operation of the train brakes affected in any ay by the independent application of the locomotive brakes?

A. No.

Q. 205. How is the independent application of the loco- otive brake limited to any desired cylinder pressure?

A. By returning the independent brake valve handle to *lap* osition.

Q. 206. How can the locomotive brake be released by the dependent brake valve?

A. (a) If the automatic brake valve handle is in *running* osition, move the independent brake valve handle to *running* osition.

(b) If the automatic brake handle is *not* in *running* posi- on, the independent brake valve handle must be moved to *release* osition.

Q. 207. Can the locomotive brake be released without in ay way interfering with the train brakes under any and all onditions?

A. Yes; by placing the independent brake valve handle in *elease* position.

TESTING AND OPERATING THE ET EQUIPMENT.

TESTING LOCOMOTIVE BRAKE.

Q. 208. Preparatory to making a test of the brake what hould be done?

A. Blow out the brake pipe and signal pipe by opening and losing quickly a number of times the angle and stop cocks, both t the pilot and rear of the tender.

Q. 209. Why is this done?

A. To remove scale and other foreign matter that may be in ie brake and signal pipes.

Q. 210. What observations should the engineer make before aking the engine to the train?

A. He should observe by the gages that the proper pres- ures are present indifferent parts of the system. This will show hat the regulating devices (governors, feed valves, etc.) are roperly adjusted. He should also observe that the brake is in roper condition generally.

Q. 211. What test should then be made?

A. The brake should be applied and released with both the utomatic and independent brake valves, to determine if the brake in proper operative condition.

MANIPULATION OF LOCOMOTIVE AND TRAIN BRAKES.

Q. 212. What is the proper position of the automatic and independent brake valve handles when not being operated?

A. *Running* position.

Q. 213. After attaching the engine to the train in what position should the automatic brake valve be carried while charging the train brakes?

A. *Release* position.

Q. 214. How long should the brake valve handle be left in this position?

A. Until the brake pipe system is charged to the pressure to be carried.

Q. 215. How should the automatic brake valve be handled when testing the brakes?

A. A full service application of the brakes should be made and the handle then moved to *lap* position.

Q. 216. How should the brakes be released?

A. Place the brake valve handle in *release* position for the proper length of time, then return it to *running* position, leaving it there.

Q. 217. If the brakes apply in emergency from an unknown cause, while train is running, what should be done?

A. Move automatic brake valve handle quickly to *emergency* position and leave it there until train stops.

Q. 218. Why is this done?

A. To insure the brakes remaining applied and to prevent loss of main reservoir pressure.

Q. 219. What must be done in the event of sudden danger?

A. Move the automatic brake valve handle quickly to *emergency* position and leave it there until the train stops and the danger is past.

Q. 220. With brakes applied in emergency, would anything be gained by moving the independent brake valve handle to *application* position?

A. No. Because in an application of this kind the application cylinder pressure is higher than the maximum pressure obtainable with the independent brake.

Q. 221. If, in making a stop, the driving wheels slide, can they be released?

A. Yes; by placing the independent brake valve handle in *release* position and holding it there until the wheels again revolve, reapplying the brakes, if desired, with this brake valve.

. 222. In the event of releasing and reapplying the loco-
'e brake in this manner, in what position should the inde-
ınt brake valve handle be left after the application is made?

. *Running* position.

. 223. Why?

. Because if left in any other position the locomotive
: cannot be released by the automatic brake valve.

. 224. Does the releasing and reapplying of the engine
ender brakes with the independent brake valve in this way
any effect on the train brakes?

. No; as the operation of the independent brake valve
not interfere with the train brakes.

. 225. In making a service application, how should the
natic brake valve be handled?

. The same as with the older types of brake valves.

. 226. In making the first release of a two-application
how should the brake valve be handled?

. (a) With short passenger trains release the brakes by moving the brake valve handle to *running* position a sufficient length of time to start the locomotive and train brakes releasing, then to *lap* position.

(b) With the long passenger trains the brake valve handle should be moved to *release* position for about three seconds to start the train brakes releasing, then to *running* position to partly release the locomotive brake, then to *lap*.

. 227. In making the final release of a two-application
how should the automatic brake valve be handled?

. (a) With short passenger trains, release the brakes just before coming to a stop by moving the brake valve handle to *running* position and leaving it there.

(b) With long passenger trains, the brakes should be held applied until the train stops.

. 228. In making a release after a one-application stop,
should the brake valve be handled.

. The same as a final release of a two-application stop,
st explained.

. 229. Why is it necessary to move the automatic brake
handle promptly to *running* position after going to *release*
leasing the brakes?

. Because with the brake valve in *release* position, the
)tive brake is held applied.

Q. 230. What is the only position of the automatic brake valve handle which will permit the release of both the locomotive and train brakes together?

A. *Running* position.

Q. 231. Is there any other position besides ***running*** position which will release train brakes?

A. Yes; ***release*** position and ***holding*** position.

Q. 232. Is there any other than running position in which the locomotive brake can be released by the automatic brake valve?

A. No.

Q. 233. Can the locomotive brake always be released by placing the automatic brake valve handle in ***running*** position?

A. No.

Q. 234. Why?

A. Because if the independent brake valve handle is not in *running* position, the locomotive brake cannot be released by the automatic brake valve.

Q. 235. If the driving wheels pick up and slide while making a stop, what should be done?

A. Release with the independent brake valve.

Q. 236. In handling a light locomotive, which brake valve should be used?

A. The independent brake valve.

Q. 237. For a gradual application of the locomotive brake, how should the independent brake valve be used?

A. Place the brake valve handle in ***slow-application*** position until the brake is sufficiently applied; then return it to *lap* position.

Q. 238. How operated if a quick application of the locomotive brake is desired?

A. Place the independent brake handle in quick-application position until the brake is sufficiently applied, then return it to *lap* position.

Q. 239. Should the independent brake valve be used in completing a train stop?

A. No.

Q. 240. Why?

A. Because to apply the locomotive brake with the train brakes released will cause slack to run in and produce shocks.

Q. 241. In case of emergency, should the independent brake valve be used on a light locomotive?

A. No; in *all* cases of emergency, move the ***automatic*** brake valve handle to *emergency* position.

Q. 242. Why?

A. Because a considerably higher brake cylinder pressure is obtained than would be possible with the use of the independent brake valve.

Q. 243 How can the locomotive brake always be released regardless of the position either brake handle may be in?

A. By placing the independent brake valve handle in *release* position.

Q. 244. How can the locomotive brake be held applied while releasing the train brakes?

A. By moving the automatic brake valve handle to either *release* or *holding* positions.

Q. 245. Can this be done in any other way?

A. Yes; by placing the independent brake valve handle in *lap* position.

Q. 246. Why should not the independent brake valve be used for this purpose?

A. First—Because it is better to use the automatic brake valve alone instead of in conjunction with the independent brake valve. Second—Because if the independent brake valve is used for this purpose, it may be left in *lap* position by mistake and the proper operation of the brakes by the automatic brake valve interfered with.

Q. 247. Why should the automatic brake valve handle never be left in *lap* position except while bringing the train to a stop?

A. Because if the handle is left in *lap* position when the brakes are not applied, brake pipe leakage may materially reduce the brake pipe and auxiliary reservoir pressures, so that full braking power cannot be obtained and because the driver brakes are likely to apply as the outlet from the application chamber is closed.

Q. 248. If, after a brake application, the automatic brake valve handle is moved to *release* position and returned to *lap* position, what will be the result?

A The locomotive brake will remain applied.

Q. 249. What is the advantage of having the locomotive brake remain applied under these conditions?

A. It would serve as a warning in case of neglect to move the handle to the proper position.

Q. 250. Would anything be gained by moving the automatic brake valve handle to *release* position for a short time just before making an application of the brakes?

A. No; this should never be done.

Q. 251. Why?

A. Because by placing the automatic brake valve handle in *release* position the brake pipe will be charged higher than the pressure in the auxiliary reservoirs; consequently, the brakes cannot be applied until after this difference in pressure has been drawn off.

FREIGHT BRAKING.

Q. 252. What feature of the No. 6 ET Equipment is of particular advantage in handling trains on long, descending grades?

A. The ability to handle the locomotive brake with or entirely independent of the train brakes.

Q. 253. What is gained by this?

A. The locomotive and train brakes can be alternated without interfering with each other.

Q. 254. With all the brakes applied, can the locomotive brake be released without releasing the train brakes?

A. Yes.

Q. 255. How can this be done?

A. By placing the handle of the independent brake valve in *release* position, holding it there until the brake is released.

Q. 256. After releasing in this manner, where should the handle of the independent brake valve be placed?

A. *Running* position.

Q. 257. If it is then desired to release the train brakes and recharge the reservoirs, and reapply the locomotive brakes, in order to assist the retaining valves, in holding the train, how can this be accomplished?

A. Place the independent brake valve handle in *application* position until the desired locomotive brake cylinder pressure is obtained, then return it to *running* position, then move the automatic brake valve handle to *release* position and leave it there until the train is charged.

Q. 258. What is the maximum pressure obtainable in the brake pipe under these conditions?

A. As the excess pressure head of the duplex governor will be in control, the maximum pressure obtainable will be twenty pounds above that ordinarily carried in the brake pipe.

Q. 259. When reapplying the train brakes, how can excessive locomotive brake cylinder pressure be prevented?

A. By partially releasing the locomotive brake with the independent brake valve before reapplying the train brakes.

Q. 260. How can the overheating of driving wheel tires be prevented?

A. By either holding the independent brake valve handle n *release* position when making an automatic application or by releasing immediately with the independent brake valve after the utomatic application.

Q. 261. When releasing the brakes on a freight train when n motion should the automatic brake valve be handled in the ame manner as with passenger trains?

A. No; the brake valve handle should be moved to *release* osition and allowed to remain there for a period of time, ac-ording to the length of the train, but not to exceed twenty sec-nds.

Q. 262. Why should this be done?

A. To insure a proper release of the train brakes and hold he locomotive brake applied, thus preventing the slack of the rain running out.

Q. 263. In making releases on long trains, after brake alve handle has been returned to *running* position, should it gain be moved to *release* position for an instant?

A. Yes; after being in *running* position for about three sec-nds.

Q. 264. Why?

A. Because in making such a release some of the head rakes may have been overcharged and may reapply.

BROKEN PIPES.

Q. 265. What would be the result if the brake pipe branch o the distributing valve broke off?

A. The locomotive and train brakes would apply.

Q. 266. What should be done if this happens on the road?

A. Plug the end leading from the brake pipe; release the ocomotive brake by placing the independent brake valve handle n *release* position and proceed.

Q. 267. Would it be possible to use the locomotive brake n this case?

A. Yes; with the independent brake valve, always using *release* position to release the brake.

Q. 268. What would be the result if any of the pipe con-ections between the distributing valve and the brake cylinders roke off?

A. It would permit a constant escape of air when the brake s applied and may cause the release of one or more of the lomo-notive brake cylinders, depending on where the break occurs.

Q. 269. What should be done in a case of this kind?

A. If the pipe cannot be repaired, close the cut-out cock in the pipe leading to the broken pipe. If breakage occurs next to the distributing valve reservoir, close the cut-out cock in the distributing valve supply pipe.

Q. 270. What would be the effect if the supply pipe to the distributing valve broke off?

A. It would permit main reservoir pressure to escape and prevent the use of the locomotive brake.

Q. 271. What should be done?

A. If repairs cannot be made to the pipe, the cut-out cock in the supply pipe should be closed or the pipe plugged.

Q. 272. What would be the effect if the application cylinder pipe to the distributing valve broke off?

A. It would be impossible to apply the locomotive brake.

Q. 273. What should be done?

A. The connection to the distributing valve should be plugged and the brake could then be applied, but with the automatic brake valve only.

Q. 274. With this opening plugged and the brake automatically applied, can it be released with the independent brake valve?

A. No. It can only be released by placing the automatic brake valve handle in *running* position.

Q. 275. If the release pipe to the distributing valve breaks off, what would be the effect?

A. It would cut out the holding feature of the automatic brake valve.

Q. 276. With this pipe broken off would it interfere with the independent operation of the brake?

A. Yes; if an independent application was made and the equalizing parts of the distributing valve were in release position, it would allow the independent brake to release when the independent valve was moved to lap position.

Q. 277. With this pipe broken off and the brakes automatically applied, can they be released with the independent brake valve?

A. Yes.

Q. 278. Should any delay be occasioned by the breaking off of this pipe?

A. No. Proceed and operate the brake with the automatic brake valve but without attempting to use the holding feature.

Q. 279. What would be the effect if the pipe connection to the spring chamber of the excess pressure head of the pump governor broke off?

A. The compressor would not operate when the main reservoir pressure was about forty pounds or over.

Q. 280. What should be done in this case?

A. Plug the broken pipe and place a blind gasket in the pipe leading to the chamber below the diaphragm of the excess pressure head.

Q. 281. What should be done if the pipe connection leading to the chamber below the diaphragm of the excess pressure head breaks off?

A. Plug the broken pipe and proceed.

Q. 282. With the lower pipe to the excess pressure head plugged, or with both pipes plugged, what would control the compressor?

A. The maximum pressure head.

Q. 283. What should be done in the event of the pipe connection to the maximum pressure head breaking off?

A. Plug the pipe.

Q. 284. What would control the compressor?

A. The excess pressure head.

Q. 285. In such a case, would the excess pressure head control the compressor at all times?

A. No; only with the automatic brake valve handle in *release*, *running*, or *holding* positions.

Q. 286. What would happen if the handle were left in *lap*, *service* or *emergency* positions or it became necessary to close the main reservoir cut-out cock for any length of time?

A. The governor then being out of commission, the compressor will continue to run until air pressure and steam pressure become approximately equal.

Q. 287. What precaution should be taken with the governor out of commission in this way?

A. Compressor should be throttled so that too high a main reservoir pressure could not be obtained and in case of main reservoir cock being closed compressor should be shut off.

Q. 288. What should be done if the equalizing reservoir pipe breaks off?

A. Plug the equalizing reservoir pipe to the brake valve and the service exhaust opening. The brakes should then be applied in service by a careful use of the *emergency* position.

Q. 289. Why should extreme care be used when operating the brake valve in this manner?

A. To avoid causing quick-action and to prevent the head brakes "kicking" off when returning to *lap* position.

ROUND HOUSE INSPECTORS TEST.

General:

Q. 290. What are the objects of these tests?

A. To determine the condition of the detail parts of the ET Equipment.

Q. 291. What should be done by the round house air-brake inspector when testing the brakes preparatory to turning out the engine on the road?

A. The following cocks must be closed: The drain cocks in the main reservoirs, the brake pipe angle cocks and the signal pipe cut-out cocks at each end of the locomotive, and the ⅜-inch cut-out cock in the dead engine pipe.

The following cocks must be opened: Main reservoir cut-out cock, distributing valve cut-out cock, the double-heading cock and cut-out cocks in the brake cylinder pipes.

Both the automatic and independent brake valve handles should be in *running* position before starting the compressor.

Q. 292. When the locomotive brake system has become fully charged what should first be done?

A. Blow out the brake pipe and signal pipe by opening and closing quickly a number of times the angle and stop cocks, both at the pilot and rear of the tender.

Q. 293. Why is this done?

A. To remove scale and other foreign matter that may be in the brake and signal pipes.

Q. 294. What pressure should there be in the brake pipe and distributing valve before testing the brake?

A. The standard brake pipe pressure for the service in which the locomotive is to be used.

Q. 295. What are the parts that should be tested first?

A. The air gages.

Q. 296. What method should be employed to test the air gages?

A. Use a test gage that is known to be correct. This gage should be coupled to the front or to the rear brake pipe hose; then with system charged and automatic brake valve in *release* position, note if main reservoir, equalizing reservoir and brake pipe pressures as indicated by the air gages correspond with the pressure indicated on the test gage.

Q. 297. How should the brake cylinder gage be tested?

A. Connect the test gage to the brake cylinder, make a brake application, and see that the brake cylinder gage registers with the test gage.

Q. 298. What test should follow the gage test?

A. A test of the pump governor.

Q. 299. How should this test be made?

A. Place the automatic brake valve handle in *running* posi-on. In this position main reservoir pressure should register twenty unds higher than that in the brake pipe. Then place the handle *lap* position. In this position the main reservoir pressure ould register the maximum pressure standard on the road for e class of service to which the engine is assigned.

Q. 300. What should next be done?

A. The feed valve should be tested.

Q. 301. How should the feed valve be tested?

A. Place the automatic brake valve handle in *running* posi-on to see that the feed valve regulates the brake pipe pressure the proper standard.

Q. 302. What test should follow the feed valve test?

A. A test of the automatic rotary valve for leakage.

Q. 303. How should this be tested?

A. Make a 20-pound service reduction, place the handle on p position and close the double-heading cut-out cock under the rake valve. Harmful rotary valve leakage will be denoted in few seconds by a material increase of pressure in the equaliz-ig reservoir (shown on gage) or by the equalizing piston lift-g.

Q. 304. Would any other defect cause the equalizing pis-on to lift?

A. Yes; a leak from the equalizing reservoir, which will shown on the gage, will cause this. If the piston lifts, due a rotary valve leak, however, the gage hand does not fall.

Q. 305. What should next be done?

A. The locomotive brake pipe should be tested for leakage.

Q. 306. How should test be made for break pipe leakage?

A. Charge the brake pipe and system to maximum pres-re, then make a five-pound service application and observe the ll in brake pipe pressure as indicated by the ***brake pipe gage,*** t by the equalizing reservoir gage.

Q. 307. What should the limit of this leakage be?

A. It should not exceed five pounds per minute.

Q. 308. What test should be made to determine if the brake in good order?

A. Apply the brake by making a full service applica-n with the automatic brake valve, and if it applies properly, ease by placing the automatic brake valve handle in *running*

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The following cocks must be opened: Main reservoir cut-out cock, distributing valve cut-out cock, the double-heading cock and cut-out cocks in the brake cylinder pipes.

Both the automatic and independent brake valve handles should be in *running* position before starting the compressor.

Q. 292. When the locomotive brake system has become fully charged what should first be done?

A. Blow out the brake pipe and signal pipe by opening and closing quickly a number of times the angle and stop cocks, both at the pilot and rear of the tender.

Q. 293. Why is this done?

A. To remove scale and other foreign matter that may be in the brake and signal pipes.

Q. 294. What pressure should there be in the brake pipe and distributing valve before testing the brake?

A. The standard brake pipe pressure for the service in which the locomotive is to be used.

Q. 295. What are the parts that should be tested first?

A. The air gages.

Q. 296. What method should be employed to test the air gages?

A. Use a test gage that is known to be correct. This gage should be coupled to the front or to the rear brake pipe hose; then with system charged and automatic brake valve in *release* position, note if main reservoir, equalizing reservoir and brake pipe pressures as indicated by the air gages correspond with the pressure indicated on the test gage.

Q. 297. How should the brake cylinder gage be tested?

A. Connect the test gage to the brake cylinder, make a brake application, and see that the brake cylinder gage registers with the test gage.

Q. 298. What test should follow the gage test?

A. A test of the pump governor.

Q. 299. How should this test be made?

A. Place the automatic brake valve handle in *running* position. In this position main reservoir pressure should register twenty pounds higher than that in the brake pipe. Then place the handle in *lap* position. In this position the main reservoir pressure should register the maximum pressure standard on the road for the class of service to which the engine is assigned.

Q. 300. What should next be done?

A. The feed valve should be tested.

Q. 301. How should the feed valve be tested?

A. Place the automatic brake valve handle in *running* position to see that the feed valve regulates the brake pipe pressure to the proper standard.

Q. 302. What test should follow the feed valve test?

A. A test of the automatic rotary valve for leakage.

Q. 303. How should this be tested?

A. Make a 20-pound service reduction, place the handle on *lap* position and close the double-heading cut-out cock under the brake valve. Harmful rotary valve leakage will be denoted in a few seconds by a material increase of pressure in the equalizing reservoir (shown on gage) or by the equalizing piston lifting.

Q. 304. Would any other defect cause the equalizing piston to lift?

A. Yes; a leak from the equalizing reservoir, which will be shown on the gage, will cause this. If the piston lifts, due to a rotary valve leak, however, the gage hand does not fall.

Q. 305. What should next be done?

A. The locomotive brake pipe should be tested for leakage.

Q. 306. How should test be made for break pipe leakage?

A. Charge the brake pipe and system to maximum pressure, then make a five-pound service application and observe the fall in brake pipe pressure as indicated by the *brake pipe gage*, or by the equalizing reservoir gage.

Q. 307. What should the limit of this leakage be?

A. It should not exceed five pounds per minute.

Q. 308. What test should be made to determine if the brake is in good order?

A. Apply the brake by making a full service application with the automatic brake valve, and if it applies properly, release by placing the automatic brake valve handle in *running*

position and note if the brake shoes properly clear the wheels and the cylinder pistons return to the end of the cylinder.

Q. 309. What other test should be made?

A. Apply the brake with the independent brake valve, noting that a full application (forty-five pounds) is registered by the red hand of the small air gage and that the hand returns to zero when the brake is fully released.

Q. 310. With the independent brake valve handle in *quick-application* position how long should it take to get forty-five pounds cylinder pressure?

A. From two to four seconds.

Q. 311. How long should it then take from the time the independent brake valve handle is placed in *release* position until the flow of air from the application chamber at the brake valve ceases.

A. From two to three seconds.

Q. 312. What should be observed regarding piston travel?

A. That the piston travel is only sufficient to give proper brake shoe clearance.

Q. 313. What is usually about the proper piston travel?

A. Driver brakes about four inches; engine truck brake about six inches, and tender brake about seven inches standing travel.

Q. 314. Why is too long piston travel objectionable?

A. It may cause a loss of the brake due to the piston striking the head or levers fouling, which will lengthen the time of release of the brake and cause a waste of air.

PUMP GOVERNOR TEST.

Q. 315. Before adjusting the pump governor, what should be observed?

A. That all air pipe connections are tight and that the vent port and drain port are open.

Q. 316. What would be the effect of a stopped-up vent port?

A. There might be a considerable drop in main reservoir pressure before the compressor would start.

Q. 317. If, in addition to a stopped-up vent port, either diaphragm pin valve were leaking, what would be the effect?

A. The compressor would not operate when the main reservoir pressure was about forty pounds or over.

Q. 318. What would be the effect of a stopped-up drain port?

A. The governor would not shut off the compressor.

Q. 319. If, with the handle of the automatic brake valve n *running* position, the main reservoir and brake pipe pressures lo not stand 20 pounds apart, where is the trouble?

A. In the adjustment of the excess pressure head of the ump governor.

Q. 320. What should then be done?

A. The excess pressure head of the pump governor should e properly adjusted.

Q. 321. Before commencing to adjust the excess pressure ead, what is it important to note?

A. First—That the maximum pressure head is adjusted igher than the standard main reservoir pressure to be carried ith the handle of the brake valve in *running* position. Second—hat the air brake pressure is known to be correct. Third—hat there is no obstruction either in the main reservoir conection to the chamber under the diaphragm of the excess pressure head or in the pipe connection to the spring chamber.

Q. 322. How should the adjustment of the excess pressure ead be made?

A. Remove the cap nut from the excess pressure head and crew the regulating nut up or down, as may be required.

Q. 323. With the automatic brake valve handle in *lap* position if the main reservoir pressure varies from the maximum emloyed on the road, where is the trouble?

A. In the maximum pressure governor head.

Q. 324. If such variation exists, what should be done?

A. The maximum head should be properly adjusted.

Q. 325. In case of a steady blow of air from the vent port hen the compressor is operating, where is the trouble?

A. A leak past the seat of one or both of the diaphragm ins valves.

FEED VALVE TEST.

Q. 326. How should the B-6 feed valve be tested?

A. With brake released and system charged to standard ressure, open the angle cock at the rear of the tender sufficiently to represent a brake pipe leakage of from seven to ten ounds per minute and observe the brake pipe gage pointer.

Q. 327. With this amount of brake pipe leakage, what should he brake pipe gage pointer do?

A. It should fluctuate.

Q. 328. What does this fluctuation of the gage pointer indicate?

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Both the automatic and independent brake valve handles should be in *running* position before starting the compressor.

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A. Blow out the brake pipe and signal pipe by opening and closing quickly a number of times the angle and stop cocks, both at the pilot and rear of the tender.

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A. To remove scale and other foreign matter that may be in the brake and signal pipes.

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A. Yes; a leak from the equalizing reservoir, which will e shown on the gage, will cause this. If the piston lifts, due) a rotary valve leak, however, the gage hand does not fall.

Q. 305. What should next be done?

A. The locomotive brake pipe should be tested for leakage.

Q. 306. How should test be made for break pipe leakage?

A. Charge the brake pipe and system to maximum pres-ıre, then make a five-pound service application and observe the all in brake pipe pressure as indicated by the ***brake pipe gage***, ot by the equalizing reservoir gage.

Q. 307. What should the limit of this leakage be?

A. It should not exceed five pounds per minute.

Q. 308. What test should be made to determine if the brake ı in good order?

A. Apply the brake by making a full service applica-ɔn with the automatic brake valve, and if it applies properly, lease by placing the automatic brake valve handle in ***running***

Q. 348. If the handle latch becomes dry, what should be done?

A. Lubricate the sides of the latch and the notches on the quadrant.

Q. 349. If, with the handle in *release, running, holding* or *lap* positions, there is a leak at the brake pipe service exhaust, what does it indicate?

A. That the equalizing piston valve is unseated, probably due to foreign matter.

Q. 350. How can this leak usually be stopped?

A. By closing the double-heading cut-out cock under the brake valve, making a heavy service application and returning the brake valve handle to *release* position. This will cause a heavy blow at the service exhaust fitting and usually remove the foreign matter and allow the valve to seat.

Q. 351. With the handle of the automatic brake valve in *service application* position, brake pipe pressure seventy pounds, how long should it take to reduce the equalizing reservoir pressure twenty pounds?

A. From six to seven seconds.

Q. 352. From a brake pipe pressure of 110 pounds, how long should it take?

A. From five to six seconds.

Q. 353. In case the equalizing reservoir pressure reduces considerably faster than the time given, what is the probable cause?

A. Either an enlarged preliminary exhaust port, leakage past the rotary valve, seat, lower gasket, or in the equalizing reservoir and its connections to the brake valve or gage.

Q. 354. If the reduction is materially slower than the figures given, what is probably the cause?

A. A partial stoppage of the preliminary exhaust port or leakage into the equalizing reservoir.

Q. 355. How should test be made for a leaky rotary valve?

A. By placing the brake valve handle in *service* position and allowing it to remain there until the brake pipe gage pointer drops to zero; then close the double-heading cock under the brake valve and place the brake valve handle on *lap*. If a blow starts at the brake pipe exhaust, it indicates a leak by the rotary valve into the brake pipe; if an increase of pressure is noted on the equalizing reservoir gage it indicates a leak past the rotary valve or body gasket into the chamber above the equalizing piston and reservoir.

Q. 356. During this test, if an increase of brake cylinder pressure results or the safety valve blows intermittently, what does it indicate?

A. A leak by the rotary valve into the application cylinder the distributing valve.

Q. 357. With the brake valve handle on *lap* position after aking a service application, if the brake pipe service exhaust ntinues to blow and the air gage indicates a fall in pressure in th the equalizing reservoir and brake pipe, where should the ouble be looked for?

A. In the equalizing reservoir and its connections, both to e brake valve and to the air gage, and also the inner tube of e gage.

INDEPENDENT BRAKE VALVE TEST.

Q. 358. What are the important things to observe in con-ection with the independent brake valve?

A. That no external leakage exists in the brake valve or its pe connections and that the handle and return spring work eely and properly.

Q. 359. What can cause the handle to move hard?

A. Lack of lubrication on the rotary valve and seat, rotary lve key and gasket or handle latch, same as with the auto-atic brake valve.

Q. 360. What should be done to make the handle move eely?

A. Follow the same recommendations as prescribed for the utomatic brake valve.

Q. 361. Should the handle continue to work hard after the arts have been lubricated, where is the trouble?

A. Probably something is wrong with the return spring or s housing.

Q. 362. How should test for leaky rotary valve be made?

A. Make a partial independent application of the brakes, lace the handle on *lap*, and note if brake cylinder pressure in-reases gradually to the limit of adjustment of the reducing alve.

Q. 363. Should the handle fail to automatically return to *unning* position or to *slow-application* position, what is the prob-ble cause?

A. Too much friction of the moving parts or a weak or roken return spring.

DISTRIBUTING VALVE TEST.

Q. 364. With the system charged to standard pressure, if a ve-pound service reduction in brake pipe pressure fails to apply ie locomotive brake, what is the probable cause?

A. Excessive friction in one or more of the operative parts the distributing valve.

Q. 365. How should the test be made to determine which of the operating parts caused the trouble?

A. By recharging and then making a slow independent application. If the brake applies properly, the indications are that the trouble is in the equalizing portion of the distributing valve; if it does not, the indications are that it is in the application portion.

Q. 366. How frequently should the distributing valve be cleaned and oiled?

A. At least every six months.

Q. 367. What parts of the distributing valve should be lubricated?

A. All operating parts.

Q. 368. If water is found in the distributing valve, what is usually the cause?

A. Improper piping on the locomotive; not sufficient length of radiating pipe between the compressor and reservoirs.

Q. 369. How should the equalizing piston, slide valve and graduating valve be removed from the distributing valve?

A. Remove the equalizing cylinder cap and carefully pull out the piston and valves so as not to injure them.

Q. 370. How should the application piston, application valve and exhaust valve be removed?

A. First take off the application valve cover and remove the valve, then take out the application valve pin, after which the application cylinder cover should be removed and the piston and exhaust valve carefully pulled out.

Q. 371. Must the application valve pin always be removed before attempting to take out the application piston and exhaust valve?

A. Yes; if this is not done, damage will result, as the piston *cannot* be taken out unless the pin is removed.

Q. 372. With the valves removed from the distributing valve, what should be done?

A. Air should be blown through the ports and passages to remove any foreign matter.

Q. 373. Before assembling the parts, what should be done?

A. All seats and bushings should be thoroughly cleaned and carefully examined to see that no lint is on the seats.

Q. 374. What else should be given attention?

A. The feed groove in the equalizing piston bushing should be carefully cleaned out.

Q. 375. What should be the resulting brake cylinder pressure from a ten-pound brake pipe reduction?

A. About twenty-five pounds.

Q. 376. For each pound reduction of brake pipe pressure, hat should be the resulting brake cylinder pressure?

A. About two and one-half pounds.

Q. 377. If, after a partial service application has been ade and the brake valve lapped, the brake cylinder pressure con- nues to increase, what are the causes?

A. The most probable cause is brake pipe leakage. Others ay be a leak past the automatic rotary valve, the independent tary valve, the equalizing valve, or the graduating valve in the stributing valve.

Q. 378. What brake pipe pressure should be used wher sting the ET Equipment?

A. Seventy pounds.

Q. 379. Why?

A. With seventy pounds brake pipe pressure the point of ualization is below the adjustment of the safety valve. With 0 pounds pressure the point of equalization is above the adjust- ent of the safety valve and therefore leakage could not be so sily discovered.

Q. 380. How is the source of leaks determined?

A. By making a partial service application and observe to at figure the brake cylinder pressure rises. If it increases to ty pounds and remains constant, it indicates brake pipe leakage.

Q. 381. If the increase in the brake cylinder pressure is due a leaky rotary in the automatic brake valve, how may it be tected?

A. The brake cylinder pressure will increase up to the limit adjustment of the safety valve, causing it to blow.

Q. 382. If brake cylinder pressure increases to forty-five unds and stops, where may the trouble be looked for?

A. In the independent brake valve, due to a leaky rotary.

Q. 383. With the safety valve removed and the brake ap- ied with a partial service application, if a continuous leak exists the safety valve connection to the distributing valve, what ould probably be the cause?

A. A leaky graduating or equalizing valve.

Q. 384. If the equalizing valve leaks, how can it be de- cted?

A. By a steady discharge of air through the exhaust port the automatic brake valve when the handle of both this brake lve and the independent brake valve is in *running* position.

Q. 385. If, with a service application there is an intermit- nt blow at the brake cylinder exhaust port, what does it in- icate?

A. A leaky application valve, provided the application cylinder and the application cylinder pipe is tight.

Q. 386. What indicates exhaust valve leakage?

A. A continuous discharge of air from the exhaust port when the brake is applied.

Q. 387. If after a service application the equalizing piston, slide valve and graduating valve move to release position because of graduating valve leakage, will the locomotive release?

A. On the engine from which the brakes are being operated the locomotive brake will not release, but on the second engine in double headers or helpers with the brake valves cut out (double-heading cock closed) the locomotive brake will release.

Q. 388. Why does not the brake release on the locomotive from which the brakes are being operated?

A. Because under these conditions the automatic brake valve is on *lap;* consequently the air cannot exhaust from the application chamber.

Q. 389. Why will the brake release on the second locomotive or helper?

A. Because the release pipe is open to the atmosphere.

Q. 390. If the brake released after an automatic application, when the handle is placed in *release* or *holding* position, but remains applied after an independent application, where would you look for the trouble?

A. It is caused by a leak from the distributing valve release pipe, between the automatic and the independent brake valves.

Q. 391. If the brake releases after an independent application, but remains applied after an automatic application, what would cause the trouble?

A. A leak in the distributing valve release pipe between the distributing valve and the independent brake valve.

Q. 392. If the brake releases after either an automatic or an independent application, what would cause the trouble?

A. A leak from the application cylinder pipe or past the application cylinder cap gasket.

Q. 393. How could a weak or broken application piston graduating spring be detected?

A. If this spring becomes weak or broken, the application portion of the distributing valve would not be as sensitive to graduation.

Q. 394. How should test for leakage in the application cylinder pipe be made?

A. Make a *service* application of the brake, lap the handle and note if the brake remains applied. If it does not, it indicates that the application cylinder pipe or possibly that the application cylinder cap gasket is leaking.

Q. 395. To determine if the release pipe is leaking, how should test be made?

A. Make a service application of the brake with the automatic brake valve. If the brake remains applied with handle in *lap* position but releases when handle is returned to *holding*, it indicates release pipe leakage.

Q. 396. If the brake cylinder pressure does not remain at that to which it is applied, what is the cause?

A. Leakage from application chamber, application cylinder or their pipe connections.

BRAKE CYLINDER LEAKAGE TEST.

Q. 397. Can brake cylinder leakage be readily determined with ET Equipment?

A. Yes.

Q. 398. How?

A. By noting the number of strokes which the compressor makes in a given period of time. Then apply the brake with the independent brake valve and after the compressor has restored the main reservoir pressure again note the number of strokes. The difference in the number of strokes indicates the amount of leakage in the brake cylinders.

Q. 399. Is there any other method of determining brake cylinder leakage?

A. Yes; apply the brake with the independent brake valve, then close the cut-out cock in the distributing valve supply pipe and observe the brake cylinder gage. The gage will indicate the amount of leakage from the brake cylinders.

Q. 400. Can it be determined which of the brake cylinders is leaking?

A. Yes.

Q. 401. How?

A. Apply the brake with the independent brake valve and close the cut-out cock in the distributing valve supply pipe, then close the cut-out cocks in the pipes leading to the truck brake cylinder, driver brake cylinder and tender cylinder in order, noting the gage after each cock is closed.

SAFETY VALVE TEST.

Q. 402. What attention should be given the E-6 Safety Valve?

A. It should be noted that the safety valve is screwed properly in place, that the cap nut is screwed down on the regulating nut, making an air tight joint with the body, and that all vent holes and ports are open.

Q. 403. If the cap nut is not screwed down properly, what would be the effect?

A. The valve and its stem would have too much lift and the leakage of air around the threads of the regulating nut to the atmosphere would interfere with its proper operation.

Q. 404. How should the safety valve be tested to determine if it is properly adjusted?

A. Make an emergency application of the brake, allowing the handle to remain in *emergency* position, and note if the proper brake cylinder pressure is obtained.

Q. 405. What brake pipe pressure should be used when testing the safety valve?

A. 110 pounds.

Q. 406. Within what limits should the safety valve limit the locomotive brake cylinder pressure?

A. Between 68 and 70 pounds.

Q. 407. If the safety valve is adjusted at 68 pounds, and the pressure increases above 70 pounds, what would be the cause?

A. The holes leading from the spring chamber of the valve are restricted or the piston valve has worn loose.

Q. 408. If the safety valve permits the pressure to reduce considerably below 68 pounds before closing, what would be the trouble?

A. The holes leading from the spring chamber of the valve have been enlarged or gum or dirt has made the piston valve too close a fit.

Q. 409. Within what limits should the safety valve limit the locomotive brake cylinder pressure for ordinary service applications (110 lbs. brake pressure)?

A. Between 65 and 70 pounds.

AIR SIGNAL SUPPLY SYSTEM TEST.

Q. 410. In testing the air signal, what should first be done?

A. The signal pipe should be charged and all stop cocks, joints and unions carefully examined for leakage.

Q. 411. How can it be determined whether the proper pressure is being carried in the signal line?

A. By attaching a test gage to the signal line hose.

Q. 412. What would a too high signal pipe pressure indicate?.

A. That the reducing valve was improperly adjusted or was leaking.

Q. 413. What effect might this have?

A. In combination with a leaky signal line it might cause the signal whistle to blow when an independent application of the brake is made.

Q. 414. How can reducing valve leakage be determined?

A. By making a signal pipe reduction and noting if the pressure gradually increases after the standard maximum signal pipe pressure has been attained.

Q. 415. With a reasonably tight signal pipe, if the whistle blows when an independent application of the brake is made, what would be the cause?

A. A leaky check valve in the combined strainer and check valve.

Q. 416. If, in charging up the signal pipe the test gage indicates a too slow increase of pressure, where should the trouble be looked for?

A. Probably an obstruction in the strainer or choke fitting or a loose fitting feed valve piston.

Q. 417. If, with the signal system of the locomotive fully charged, the signal whistle blows, what is the probable cause?

A. Leakage in the signal system and a sluggishly operating reducing valve.

WESTINGHOUSE COMPOUND AIR PUMPS.

ESTINGHOUSE COMPOUND AIR PUMPS.

Coincident with the changes made in the operation of trains ipped with standard brake apparatus, other factors of air con- nption have become associated with the brake system and have posed upon the air pump greatly increased demands. Air in ge quantities is used not only in the air brake system but by nerous adjuncts such as bell-ringers, track-sanders, water- opes, water-raising system of Pullmans, and other accessories on ines and cars, all of which require more or less air to operate m, and in addition contribute to leakage, the net result of which oses a heavy burden on the air pump. As a result a demand pumps of increased capacity has sprung up and the consumption steam in operating them has become a matter of importance.

To meet these conditions, the Westinghouse Air Brake Company nufactures different types of Compound Pumps, the largest of ch greater capacity than was at one time thought possible and the same time making entirely practical an economy in steam sumption in excess of anything heretofore thought practical. these pumps the Tandem has three cylinders, one above the other, steam cylinder being on top.

The low-pressure air cylinder is 11x12 inches, the same as the ndard 11-inch pump; the high-pressure air cylinder is 6¾ inches liameter and the steam cylinder eight (8) inches in diameter. It l be observed that this pump is a two-stage compressor, and while area of the low-pressure cylinder is the same as the 11-inch np, and should theoretically take in the same volume of free air stroke, as a matter of fact, it is of considerably greater capacity n that pump, and it will also be obvious that a decided steam nomy must result from employing a steam cylinder, the area of ch is nearly 50 per cent. less than that of the 11-inch pump.

In designing this pump, interchangeability was maintained so as posssible, and to an extent that the valve gear, air valves, l various other detail parts are of the 9½-inch pump standard.

Of the cross compound design of pumps the largest, known as 8½-inch Cross Compound, will be described and its points of eriority considered. As illustrated in Figs. 1 and 2, this pump f the siamese type, having two steam and two air cylinders ar- ged side by side respectively, the steam cylinders being at the top, is the usual Westinghouse practice. The high-pressure steam nder is 8½ inches in diameter; the low-pressure 14½ inches in meter, both having 12-inch stroke. The low-pressure air cylinder, ated under the high-pressure steam cylinder, is 14½ inches in meter and the high-pressure air cylinder, located under the low- ssure steam cylinder, 9 inches in diameter. The valve gear is the top head of the high-pressure steam cylinder and is of a de- n similar to that of the 9½ and 11 inch pumps.

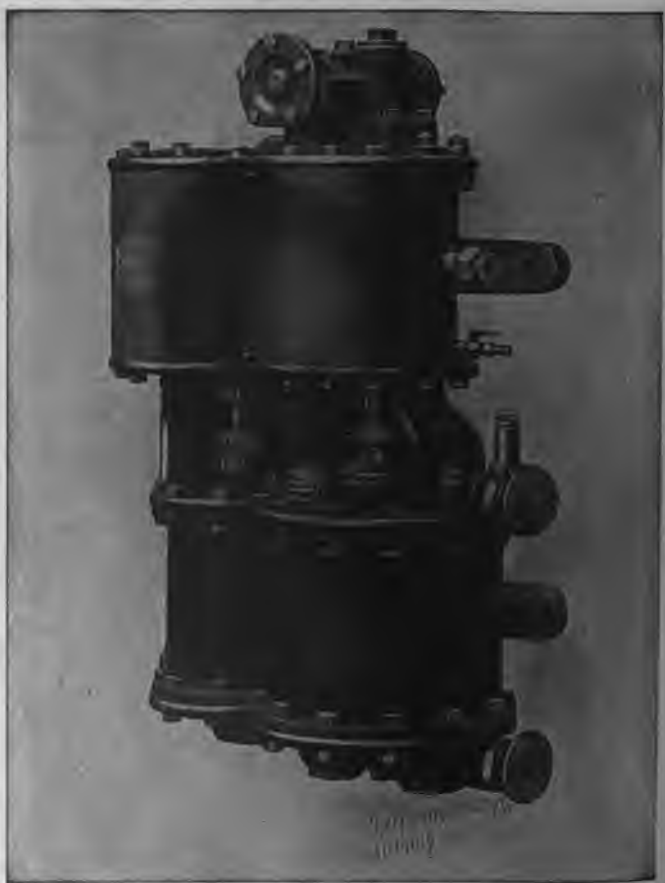

FIG. 1. 8½-INCH CROSS COMPOUND PUMP

The high-pressure steam piston, with its hollow rod, contains the reversing-valve rod, which operates the reversing valve, and it in turn the main valve and its slide valve, which controls steam admission to and exhaust from both the high and low-pressure steam cylinders.

The low-pressure steam and high-pressure air pistons are connected by a solid piston rod, having no mechanical connection with the valve gear, being simply floating pistons.

The operation of the steam in the steam cylinders, (to supply which requires a throttle pipe only one inch in diameter), is on the same principle as in two-cylinder compound engines generally, steam from the boiler being admitted to the high-pressure cylinder; then, after doing its work, expanded to the low-pressure cylinder, and from thence exhausted to the atmosphere, the two pistons being in motion at the same time, but moving in opposite directions.

Free air is taken into the larger air cylinder and by compression forced into the smaller or high-pressure one, then, in turn, recompressed and discharged into the main reservoir.

In this type of pump the principal objects of attainment sought are the continuance of the well-tried out mechanical features of former pumps, simplicity, capacity, and economy, and how these have been accomplished will be pointed out.

Referring to the first, nothing of an experimental character has been introduced in the pump mechanism. To the second, simplicity, the only additional parts to those composing the present standard 9½ and 11-inch pumps are, a second air and steam cylinder with their pistons and solid piston rod and two air valves, one in each of the two passages connecting the low and high-pressure air cylinders. As to capacity and economy, the first is attained by more closely approximating theoretical conditions in the air cylinders than is possible with simple or duplex pumps, while the economy is a result of compounding the steam, less packing-ring leakage in both the steam and air cylinders, as well as almost wholly eliminating thumping and pounding, something which has proven inherent and, to an extent, destructive to other types of locomotive air compressors.

As already stated, the valve gear and its operation is essentially the same as that of the 9½-inch and 11-inch pumps. The reversing valve performs the same duties and is operated by the reversing-valve rod in the same manner as that of the 9½-inch and 11-inch pumps.

The main slide valve is provided with the usual exhaust cavity, and in addition has four elongated steam ports in its face. The two outer and one of the intermediate ports communicate with two cored passages extending longitudinally in the valve and serve to make the proper connection between the high and low-pressure cylinders during the expansion of steam from one to the other. The remaining port controls the admission of steam to the high-pressure cylinder. The arrangement of the ports is such as to have a balancing tendency to the slide valve, thereby acting as a preventive of un-

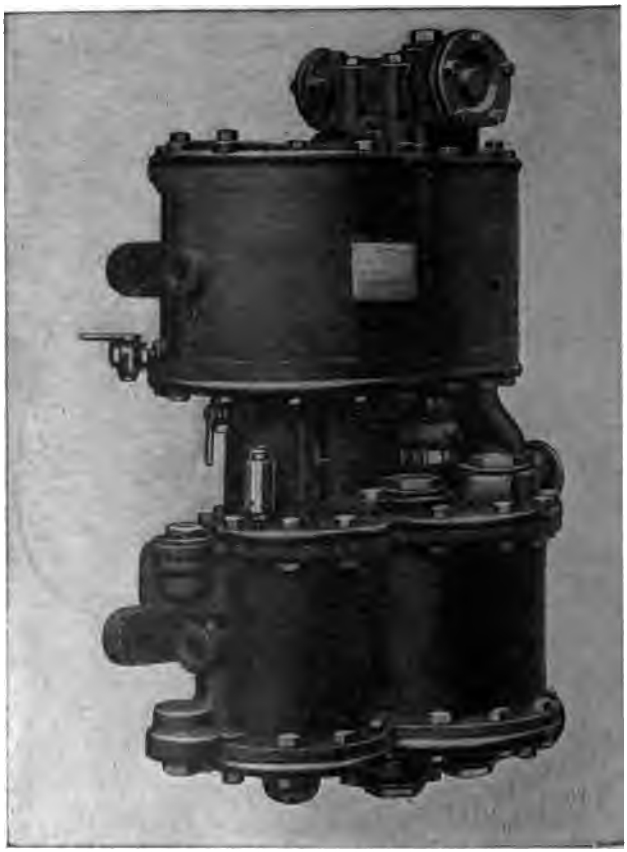

FIG. 2. $8\frac{1}{2}$-INCH CROSS COMPOUND PUMP

Even wear of the valve face and seat. The cavity governs the exhaust from the low-pressure cylinder to the atmosphere.

The valve seat has five ports. Of these the two back ones lead to the bottom and top ends respectively, of the high-pressure cylinder; the first and third ports to top and bottom ends of the low-pressure cylinder and the second port to the exhaust. Figs. 3 and 4 are diagrammatic views of the 8½-inch Cross Compound Pump in up and down stroke, the ports and passages being arranged to clearly indicate the passage of steam through them.

While steam is being admitted to the bottom end of the high-pressure cylinder, carrying its piston upward, the main slide-valve cavity opens the bottom end of the low-pressure cylinder to the exhaust and at the same moment its cored passages connect the top and of the high and low pressure cylinders, thus expanding the steam from above the high-pressure piston to the top end of the low-pressure cylinder, moving the piston of the latter downward. During this time free air is being taken into the bottom end of the low-pressure air cylinder, while that in the top end is being compressed into the high-pressure cylinder. During the piston stroke this intermediate pressure is being built up from atmosphere to about 40 pounds, a result of compressing the air from the large into the small air cylinder, a similar increase obviously taking place above the high-pressure air piston and which exerts a downward force on that piston the same as does the steam above the low-pressure steam piston. On the opposite or lower side of the high-pressure air piston, the intermediate air under compression to the main reservoir is exerting a resistance equal to the area of the piston plus the main reservoir pressure and which is greatly less than the combined steam and air pressures on top of their respective pistons.

When the pump mechanism is reversed, the action is simply a repetition of that above described.

That cylinder packing-ring leakage is considerably reduced as a result of compounding is apparent. With simple or dulex pumps, in both the steam and air cylinders, one side of their respective pistons is exposed to atmospheric pressure. With the compound pump, while steam is exerting its force on one side of the high-pressure piston, the other side is subjected to such pressure as obtains from a restricted exhaust and expansion into the low-pressure cylinder. In this low-pressure cylinder, while the exhaust side of the piston is exposed to the atmosphere, the maximum steam pressure on the opposite side of the piston is, as the name implies, comparatively low, and which reduces packing-ring leakage accordingly.

As already pointed out, the pressure in the low-pressure air cylinder never exceeds 40 pounds, and as it is compressed into the high-pressure cylinder, the building up of this intermediate pressure in the latter cylinder takes place at the same time that the high pressure is being built up and discharged to the main reservoir on the opposite side of the piston.

Thus the tendency of packing-ring leakage is largely reduced in all cylinders, a result of less differential pressure on opposite sides

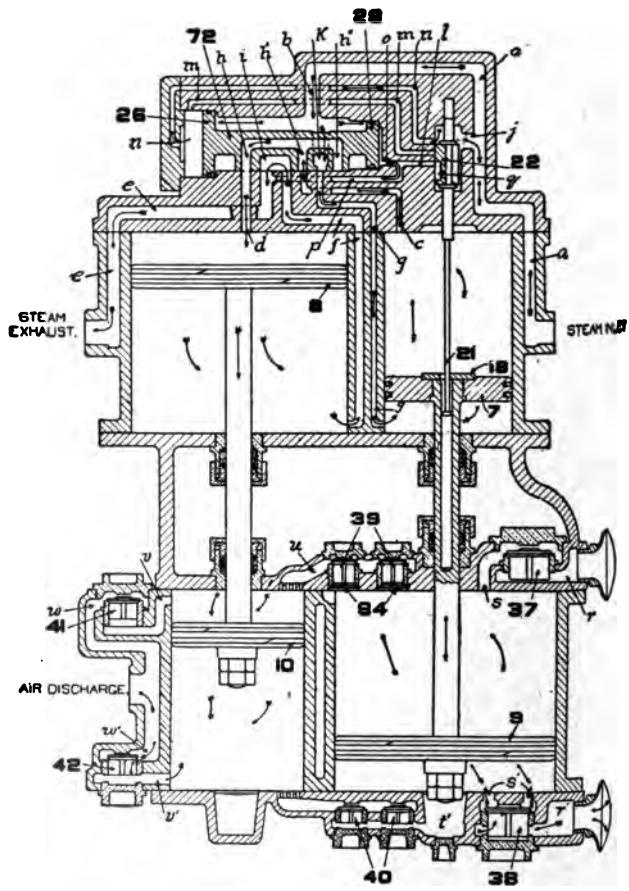

FIG. 3. DIAGRAM OF 8½-INCH CROSS-COMPOUND COMPRESSOR. RIGHT-HAND SIDE, UP-STROKE; LEFT-HAND SIDE, DOWN STROKE.

the pistons and which cannot be provided for in simple or duplex mps.

Another factor contributing to pump capacity is the low maxi- m pressure obtained in the low-pressure air cylinder. As this ssure does not exceed 40 pounds, the air occupying the clearance ce when the piston starts on its return stroke, quickly expands vn to atmosphere, permitting the taking in of free air more mptly and with much less piston movement than is possible when in-reservoir pressure must expand to that of the atmosphere.

This condition also permits the high-pressure steam and the low- ssure air pistons to always make their intended traverse, insuring l movement of the valve gear regardless of high or low main- ervoir pressure.

As to the high-pressure air piston, it is of little importance ether it varies in its stroke or not, as it can in no wise interfere h the valve gear travel or govern the quantity of free air taken o the pump. Therefore, its action is immaterial so long as it es into the main reservoir all the air it receives from the low- ssure cylinder.

With 200 pounds steam pressure and full throttle, the pump rking against a main-reservoir pressure of 130 pounds, the piston les are about 65 per minute; with the same steam pressure work- against 70 pounds main-reservoir pressure, about 81 cycles per nute. With 200 pounds steam pressure and pumping main- ervoir pressure from 30 to 70 pounds, the piston makes about ½ cycles per minute. Thus with the possibility of "racing" minated, the compound pump is in a great measure protected m wear and tear, something which cannot but materially reduce e cost of maintenance.

It is also worthy of note that this type of pump is less susceptible heating than those of the duplex type, which take free air into th the air cylinders. To clearly show the comparative efficiency d economy of the compound as compared to both simple and plex pumps, the following table is given:

Type of pump.	Steam pressure pounds.	Constant main res. pressure.	Cu. ft. free air per minute.	Steam consumption per 100 cu. ft. free air.
-inch	200	130	39	60
-inch	200	130	58	58
ndem	200	130	75	25.50
Y. No. 5	200	130	93.56	40.38
-inch C C	200	130	131.04	19.65

From an analysis of the figures, the compound has an air-com- essing capacity three and one-half times greater than that of the -inch pump, and is capable of compressing the same volume of air th a steam consumption one-third that of the smaller pump. It ay even be further stated that the performance of other pumps

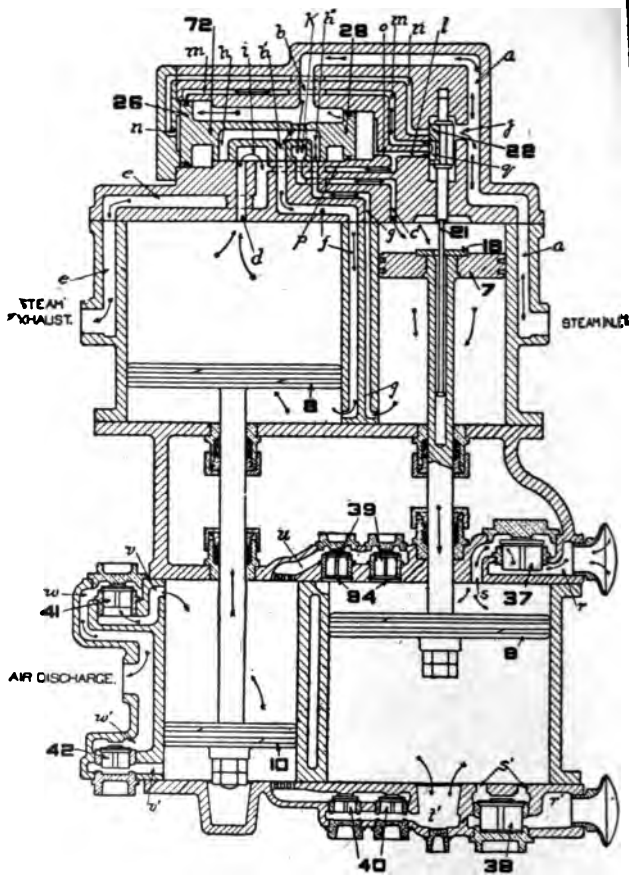

FIG. 4. DIAGRAM OF 8½-INCH CROSS-COMPOUND COMPRESSOR. RIGHT-HAND SIDE, DOWN STROKE; LEFT-HAND SIDE, UP-STROKE.

n the table, when compared to that of the 8½-inch cross com-
indicates the latter as a most useful and important contribu-
the braking art, it having the essential qualifications to meet
ls such as are being earnestly sought in conducting modern
operation.

TINGHOUSE MODERN TRIPLE VALVES.

WESTINGHOUSE MODERN TRIPLE VALVES.

The greatly changed conditions in the operation of railway trains ing the past few years incident to the employment of locomotives ıble of handling long trains of freight cars as well as the large ıber of air brakes in such trains, also the air brake requirements onnection with passenger trains of steam and electric railroads, e created conditions which the well-known types of triple valves e in many instances proven unable to meet. Realizing these ıged conditions and the great importance of successfully meeting ı, the Westinghouse Air Brake Company has somewhat recently ected a number of new triple valves which perform functions recognized as very desirable but heretofore unattainable, a ription of which follows.

By reference to cuts showing the arrangement of the ports in the valve, graduating valve and slide valve bush, it will be noted the general arrangement of ports is along each side of a longitu- l center line, rendering it somewhat difficult to follow the course ıe air through them with sectional views in which the actual ngement of ports is shown, therefore, diagrammatic cuts are for illustrating the valves in their several positions, all ports passages having been so rearranged as to place them on a single e. In preparing these cuts the actual proportion and mechani- construction of the valves has been sacrificed for the purpose of ing them as easily understood as possible.

n each of these new valves, the triple piston, slide valve and uating valve are the same in their relation to each other as in lder well-known forms of triples, the graduating valve, however, g of the sliding type and located on top of the slide valve. The e piston constitutes a movable partition separating brake pipe auxiliary-reservoir pressure. To apply or release the brake, pressure is reduced or increased until a sufficient differential is ted on opposite sides of the piston to overcome the friction of piston-packing ring and slide valve, and, as all triple valves re- d to in this paper are operated in the same manner, no attempt be made to explain these details in the description of each valve.

The practice of removing triple valves from cars for cleaning repairs is now followed almost universally. The only serious culty encountered in doing this is that pipe joints must be broken occasionally the joints are not made tight when the triple valve eplaced. The Westinghouse Company, recognizing the desir- ity of removing triple valves from cars when they require atten- , has so designed all their new triple valves, excepting those of K type, that they can be quickly removed and replaced without

disturbing any pipe joints, all of the pipe connections being permanently made to cored passages in the brake-cylinder pressure head, or triple-valve supporting bracket, to either of which the triple valve is bolted in the usual manner. These cored passages register with corresponding ports in the supporting flange of the triple valve; therefore, the only joint to be broken or made when removing or replacing a triple valve is that of the triple-valve gasket. The triple valves of this design are known as "Pipeless" Triple Valves.

In treating on the different styles of triple valves a description of but one of each type will be given, it being understood that triples designated by a certain letter are of identical construction and operation, the only change being in the area of ports and passages to accommodate each triple to the size of auxiliary reservoir and brake cylinder with which they are to be used, and which is indicated by the numeral following the letter.

K 2 TRIPLE VALVE.

The K 2 freight triple valve is similar in general appearance to the H 2 (H 49) quick-action freight triple used in connection with 10-inch brake equipments, and can be used to replace the latter on a car, as the supporting flange and pipe connection dimensions are the same. The K 2 triple performs all the functions of the older forms of freight triple valves, and in addition several other functions which automatically overcome the serious difficulties incident to the operation of trains consisting of from 50 to 100 air-braked cars, all fitted with the triple valves now in general use.

The difficulties in question and methods of correcting them are as follows:

FIRST. *The failure of a percentage of the brakes in a long train to apply.* This is caused by a back flow of air from the auxiliary reservoir to the brake pipe through the feed groove, and leakage from the brake cylinder to the atmosphere through the leakage groove. It is the result of the comparatively slow brake-pipe reduction which must be made with such trains to prevent the forward brakes building up braking power so much more rapidly than those in the rear as to create buffing strains which will always be severe and, under some conditions, destructive to draft rigging and cars.

This difficulty is corrected by adding to the triple valve, ports and passages controlled by the slide and graduating valves so arranged as to vent brake-pipe pressure into the brake cylinders while the brakes are being applied, thus reproducing to an extent, during service applications, the action of the standard triple-valve in quick action. This very materially reduces the volume of air to be discharged by the brake valve, and rapidly transmits the reduction started with the brake valve from one triple valve to another serially throughout the train, resulting in a rapid reduction of brake-pipe pressure, thus insuring the application of all brakes and very materially reducing the interval of time elapsing between the service

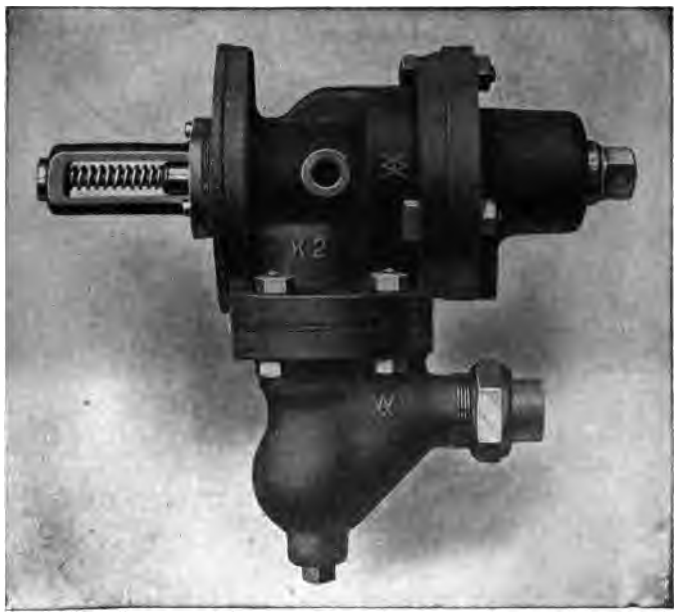

FIG. 1 THE K-2 TRIPLE VALVE

application of the front and rear brakes as compared with stand types of triple valves.

SECOND. *A complete release of the brakes at the forward end of train with standard brakes, before increase of brake-pipe pressu which has brought this about, can reach the triple valves near the r end, permits the slack to run out hard and create excessive strains the draft gear.*

This operation of the brakes is reversed by the introduction of additional release position in the K 2 triple valve designated as t "RETARDED-RELEASE" position, which can only be brought in use in the triple valves at the front end of the train. The area the exhaust port in this position is so restricted as to produce a ve slow release of brake-cylinder pressure, thus retarding the relea of the brakes at the front end of the train sufficiently to permit t rear brakes to begin to release while there is ample pressure retain in the cylinders at the front end to prevent the slack running out.

THIRD. *Overcharging the auxiliary reservoirs at the forward e*

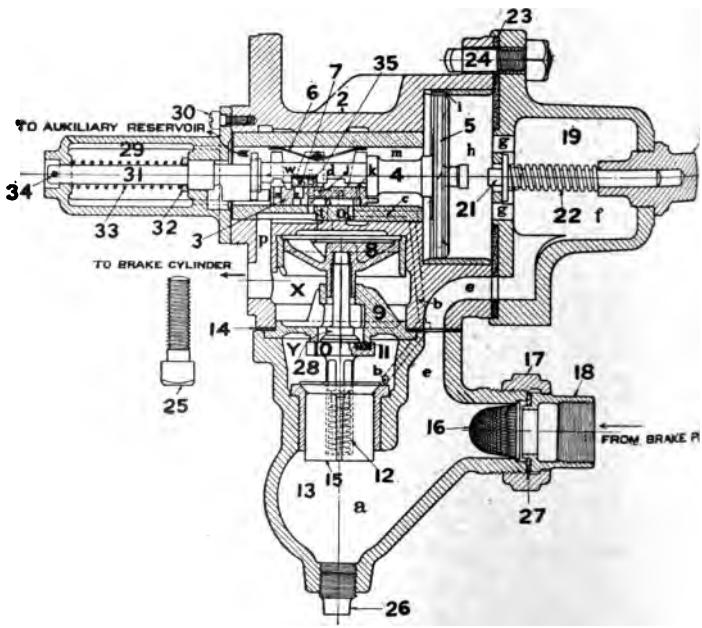

FIG. 2. THE K TRIPLE VALVE

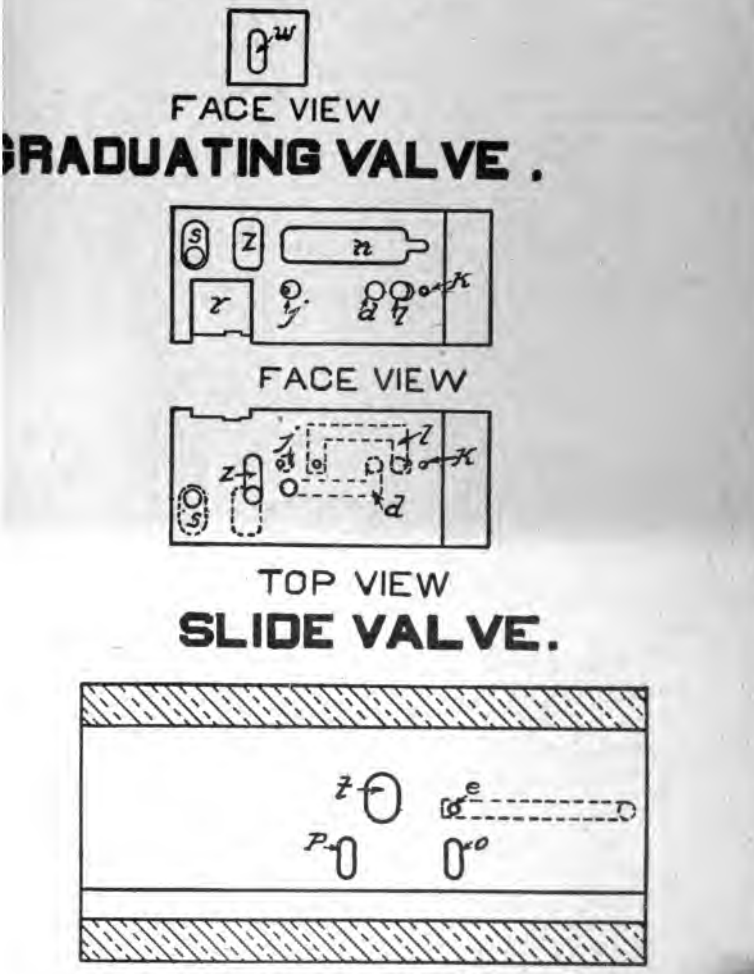

FIG. 3. THE K-2 TRIPLE VALVE

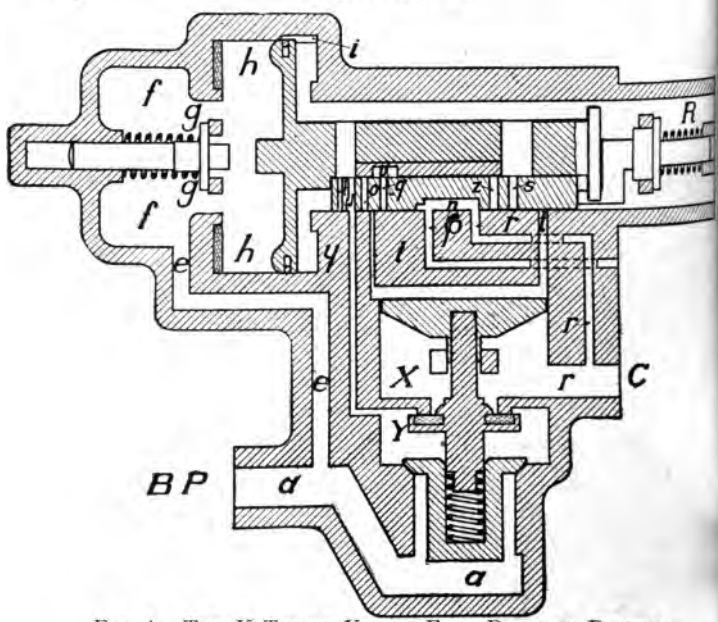

FIG. 4. THE K TRIPLE VALVE, FULL RELEASE POSITION

of a long train while releasing brakes, which results in a reapplication of them when the brake-valve handle is moved to running position.

To prevent this the K 2 triple valve has an additional charging position in which the rate of recharge of the auxiliary reservoir is materially reduced. In long trains this restricted feed can only be obtained in the triple valves at the front end where the high and quick rise of brake-pipe pressure occurs, and, therefore, is a very material aid in the uniform recharging of brakes.

CONVERTING STANDARD TRIPLE VALVES.

The standard H 1 (F 36) and H 2 (H 49) triples may be readily converted to the K types herein described, it being necessary to change but a few of the internal parts, drill port *y* in the valve body and check-valve case, and provide the triple with the retarded-release attachment.

Fig. 1 is an illustration of the K 2 triple valve complete.

Fig. 2 shows a vertical cross-section of this valve.

Fig. 3 is a plan view of the slide valve, graduating valve, and le-valve bush, showing the relative position of the ports and ities.

Operation of the K 2 Triple Valve.

Charging. Fig. 4 is a diagrammatic view of the triple valve in l-release and charging position. Air from the brake pipe enters triple valve at *a*, flows through passage *e*, *j*, *g*, chamber *h*, and feed groove *i* to chamber R and the auxiliary reservoir. The d groove *i* is of the same dimensions as that of the standard H 1 36) triple valve; therefore, it is necessary to increase the port a, through which air can feed into the auxiliary reservoir more idly and supply the greater volume required by the 10-inch brake inder. To accomplish this, port *j* in the slide valve registers h port *y*. Air then passes from the brake pipe at *a* past the check ve into chamber Y through ports *y* and *j* to chamber R and the iliary reservoir. The combined capacity of feed groove *i* and t *j* is equivalent to the feed groove of the H 2 (H 49) triple valve.

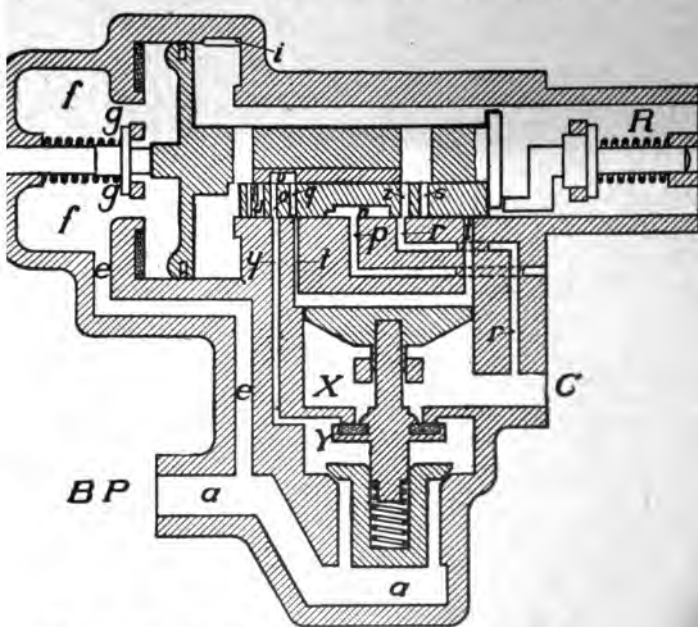

Fig. 5. The K Triple Valve, Service Position.

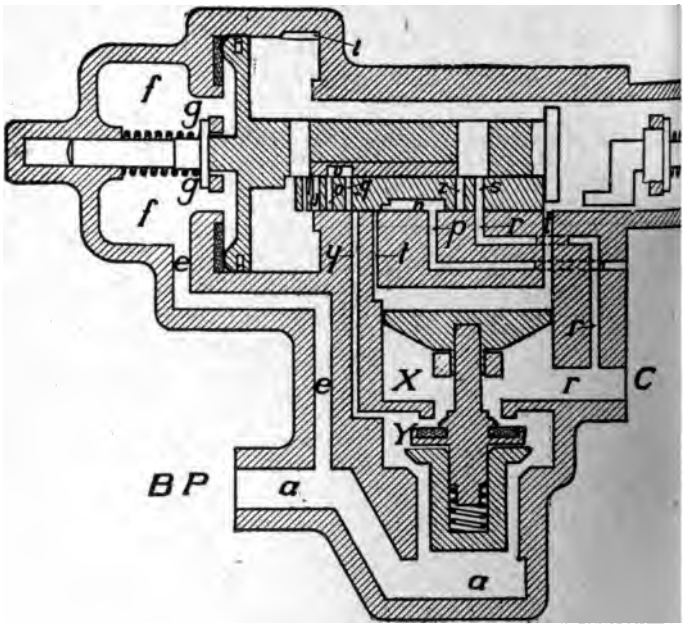

FIG. 8. THE K TRIPLE VALVE, EMERGENCY POSITION

by flowing through port *o* to the brake cylinder, making it impos for the piston and graduating valve to remain in service pos after the brake-pipe reduction to the atmosphere is stopped.

Release. The piston, slide valve and graduating valve t in service lap position, as shown in Fig. 6, raising the brake- pressure above that in the auxiliary reservoir, moves these par the right to either full release or retarded release position, dep ent upon the excess of pressure in the brake pipe over that ir auxiliary reservoir.

When the brake-pipe pressure is raised gradually, creating a slight differential pressure on opposite sides of the pistor movement is arrested in full release position by striking retar device stem 31. (See Figs 2 and 4.) In this position, the r mum exhaust opening is obtained through port *r*, cavity *n* ir slide valve, and exhaust port *p*. At the same time the auxi reservoir is recharged at the maximum rate through ports *y* and feed groove *i*, as previously described. When the rise in b

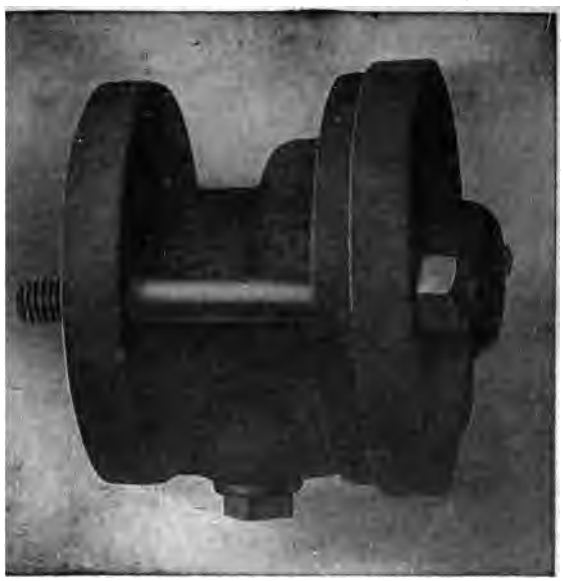

FIG. 9. THE S-1 TRIPLE VALVE

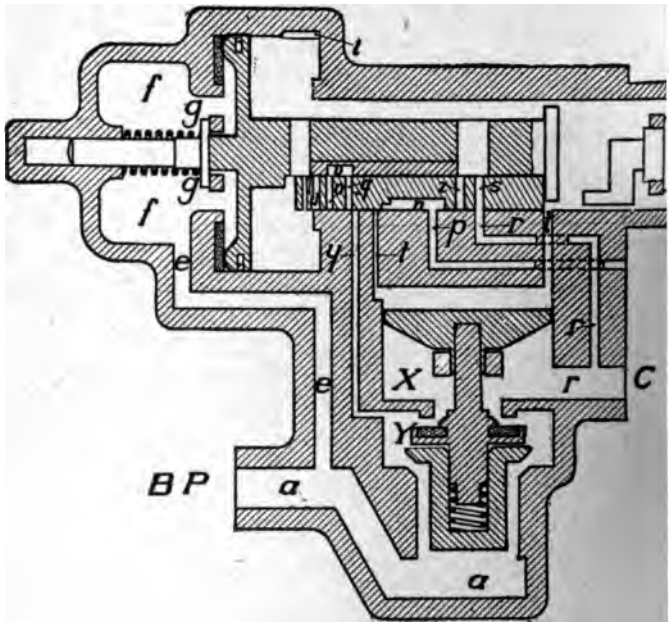

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FIG. 9. THE S-1 TRIPLE VALVE

application of the front and rear brakes as compared with standard types of triple valves.

SECOND. *A complete release of the brakes at the forward end of the train with standard brakes, before increase of brake-pipe pressure, which has brought this about, can reach the triple valves near the rear end, permits the slack to run out hard and create excessive strains on the draft gear.*

This operation of the brakes is reversed by the introduction of an additional release position in the K 2 triple valve designated as the "RETARDED-RELEASE" position, which can only be brought into use in the triple valves at the front end of the train. The area of the exhaust port in this position is so restricted as to produce a very slow release of brake-cylinder pressure, thus retarding the release of the brakes at the front end of the train sufficiently to permit the rear brakes to begin to release while there is ample pressure retained in the cylinders at the front end to prevent the slack running out.

THIRD. *Overcharging the auxiliary reservoirs at the forward end*

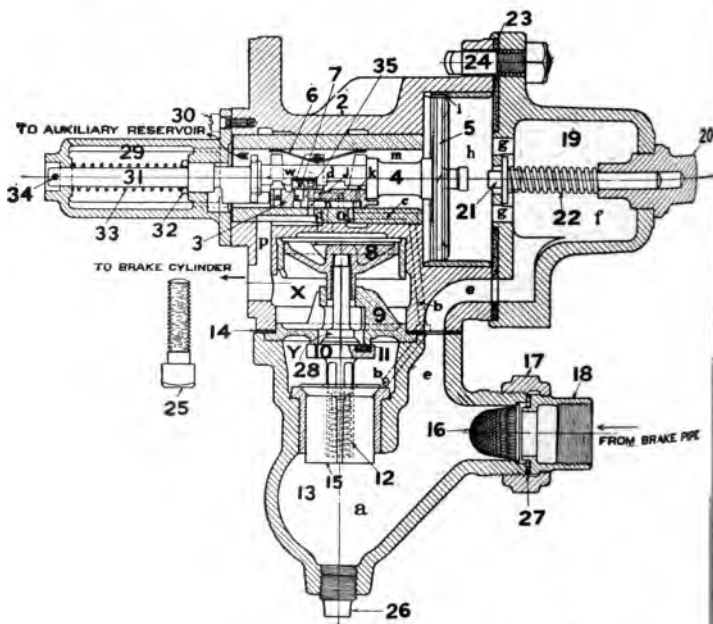
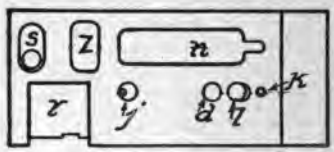


FIG. 2. THE K TRIPLE VALVE

FACE VIEW

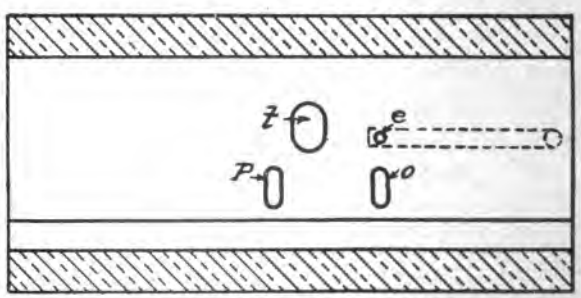
RADUATING VALVE .



FACE VIEW

TOP VIEW

SLIDE VALVE.



SLIDE VALVE BUSH.

FIG. 3. THE K-2 TRIPLE VALVE

pipe pressure is rapid enough to create a sufficient differential on the piston to compress retarding-device spring 33, the piston, slide and graduating valves are moved to the "Retarded-Release" position, shown in Fig. 7. At this time the piston is brought into contact with the end of the slide-valve bush, making a tight joint so that no air can pass from the brake pipe through feed groove *i* to the auxiliary reservoir. In this position brake-cylinder pressure is exhausted through port *r*, cavity *n* and port *p*, but this latter port *p* is partially closed by the slide valve restricting the exhaust to the area of the small extension of exhaust cavity *n* shown in Figs. 3 and 7.

This results in the auxiliary reservoir being slowly recharged through ports *y* and *l*, the area of the latter being about half that of feed groove *i* and much less than that of port *j*.

As previously explained, the pressure in the brake pipe must rise at a more rapid rate than in the auxiliary reservoir in order to move the triple-valve parts to the "Retarded-Release" and "Retarded-Recharging" position. This is possible in long trains only on about 30 cars at the front end, because the frictional resistance to the flow of air through the brake pipe prevents the building up of brake-pipe pressure in the balance of the train faster than it can flow into the auxiliary reservoirs.

Emergency. In making an emergency application of the brakes the K 2 triple has the same action as all other types of Westinghouse

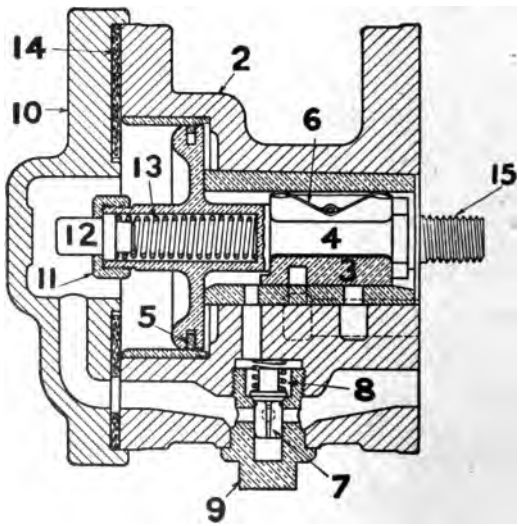


FIG. 10. THE S-1 TRIPLE VALVE

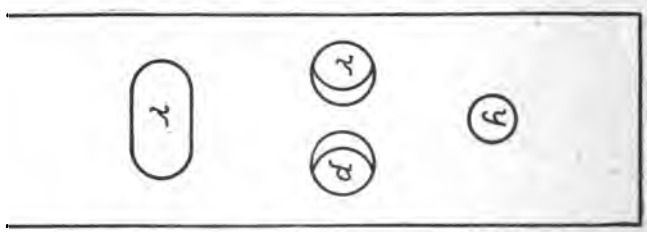


FIG. 11. THE S-1 TRIPLE VALVE

quick-action triple valves, the relative position of port openings in emergency being as shown in Fig. 8.

S 1 TRIPLE VALVE.

The S 1 triple valve is of the pipeless type and designed for use on light electric trains of not more than two cars.

It is the simplest form of plain triple valve and designed to apply brakes quickly in service applications with somewhat coarse graduations of increase in cylinder pressure, which are practicable in such street car service.

Fig. 9 illustrates the triple valve complete.

Fig. 10 is a vertical cross section of the triple valve in release position.

Fig. 11 shows the actual arrangement of ports and cavities in the seat of the slide valves and slide-valve bush.

Fig. 12 is a diagrammatic view of the triple valve in its release position. But one diagrammatic view of the valve is shown owing to the simplicity of its construction.

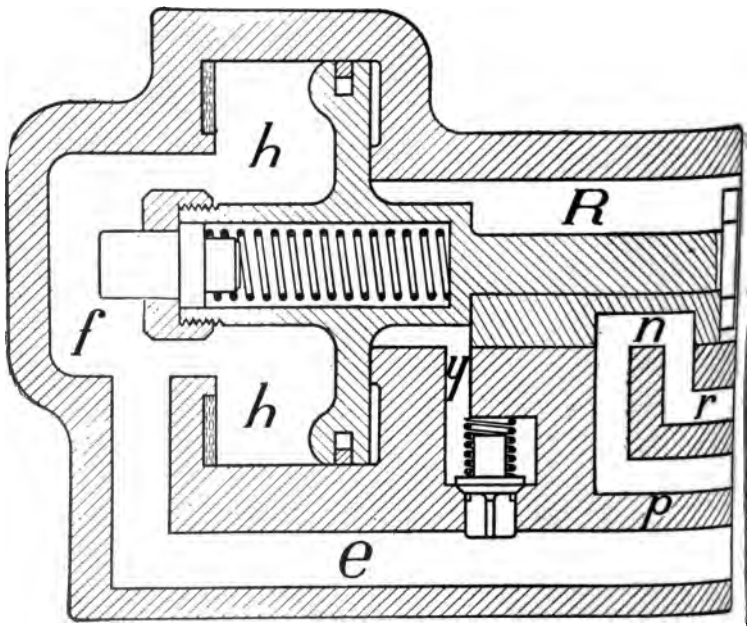


FIG. 12. THE S-1 TRIPLE VALVE

OPERATION OF THE S 1 TRIPLE VALVE.

Charging. Air from the brake pipe flows into the triple valve through passages *e* and *f* to chamber *h*, forcing the piston and its slide valve to the extreme right to release and charging position as shown in Fig. 12. Brake-pipe air in passage *e* raises the check valve, which is normally held to its seat by its spring, and flows through port *y* into chamber R and the auxiliary reservoir, quickly charging it to brake-pipe pressure.

Application. The triple valve being in release position, as shown in Fig. 12, at the beginning of a service reduction of brake-pipe pressure, the auxiliary-reservoir pressure in R moves the piston and its slide valve to the left to lap position where the graduating stem, contained in the piston, comes in contact with the triple cap, this movement closing feed port *y* and exhaust port *p*. The further reduction of brake-pipe pressure causes the piston and its slide valve to move further to the left, slightly compressing the graduating spring and opening communication from the auxiliary reservoir past the end of the slide valve to port *r* and the brake cylinder.

When the auxiliary-reservoir pressure has reduced to about equal that in the brake pipe, the graduating spring returns the parts to lap position.

The extent of piston and slide valve movement to the left in applying the brake depends entirely upon the rate of reduction in the brake pipe. This movement in all cases will be such as to open port *r* sufficiently to permit auxiliary reservoir pressure to reduce at the same rate as that in brake pipe.

Emergency. In emergency applications the piston and slide valve move to the extreme left, resulting in a full opening of port *r*, which is of large area, permitting a quick equalization of auxiliary reservoir and brake cylinder pressures.

Release. With the piston and slide valve in lap position, raising the brake-pipe pressure above that in the auxiliary reservoir, moves these parts to the extreme right, the full release position (Fig. 12), which releases the brake, the air exhausting through port *r*, cavity *b* in the slide valve and port *p*. At the same time port *y* is opened, permitting brake-pipe air in passage *e* to flow past the check valve through chamber *y* to chamber *r* and the auxiliary reservoir as already described.

Graduated Release. With this type of triple valve, the exhaust port *p* is always piped to the brake valve, which is so designed that the motorman may, by moving the brake-valve handle, permit the air to exhaust through the brake valve to the atmosphere, or retain it at will, thereby producing graduated or straight air release.

T 2 TRIPLE VALVE.

The T 2 triple valve is of the pipeless type and designed for use on trains of from one to five cars. It is of the plain triple-valve type such as is represented by the F 1 (H 24), performs all the functions of this class of triples, and in addition others, as follows:

First—"Quick Recharge" of the auxiliary reservoir.

FIG. 13. THE T-2 TRIPLE VALVE AND BRACKET.

Second—"Quick Service" application of the brake.

Third—"Graduated Release" of the brake-cylinder pressure.

It requires the usual brake pipe, auxiliary reservoir, brake cylinder and exhaust connections and an additional connection for either control pipe or a supplementary reservoir.

The use of the control pipe makes possible the graduation of the release, also an unlimited number of successive service applications without loss of braking power such as results with standard plain and quick-action triple valves. In the control pipe, a pressure of pounds is maintained by a feed valve, located in the supply pipe om the main reservoir. When a supplementary reservoir is used place of the control pipe, graduated release can be obtained, and number of brake applications may be made, without seriously epleting the braking power.

Fig. 13 illustrates the triple valve complete attached to a supporting bracket, the bracket being employed when it is desirable place the triple inside the car or other location remote from the rake-cylinder pressure head.

Fig. 14 is a vertical cross section of this valve in release position.

Fig. 15 shows the actual arrangement of ports and cavities in e seat of the graduating valve, slide valve and slide-valve bush.

Figs. 16, 17, 18, 19 and 20 are diagrammatic cuts showing the iple valve in its several positions.

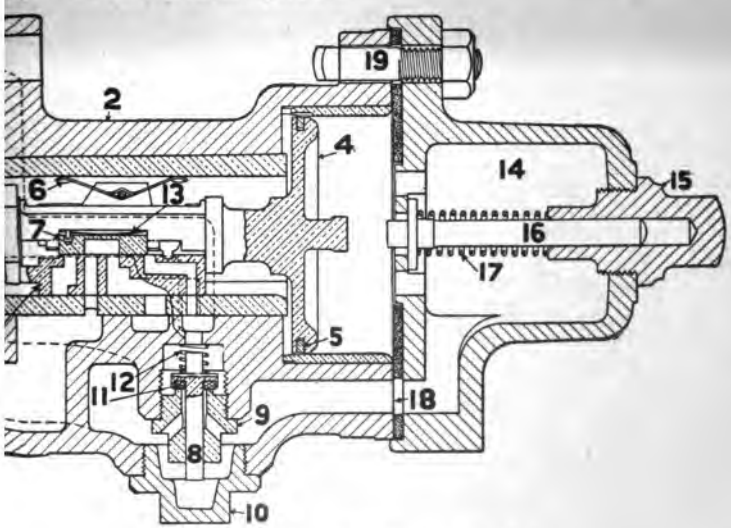


FIG. 14. THE T-2 TRIPLE VALVE.

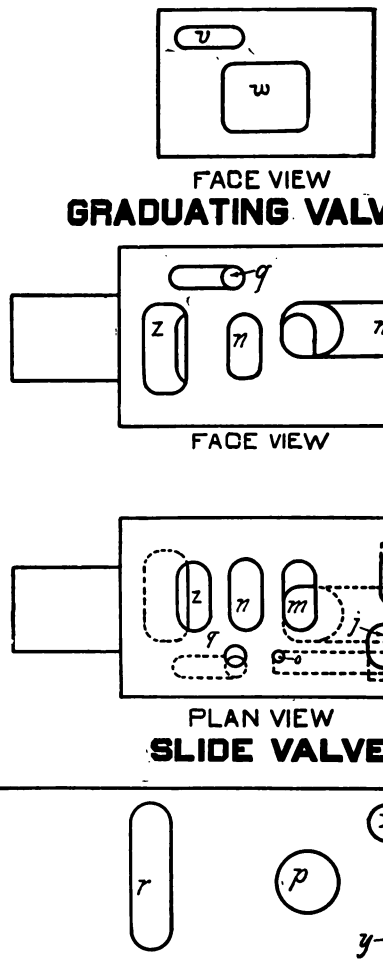
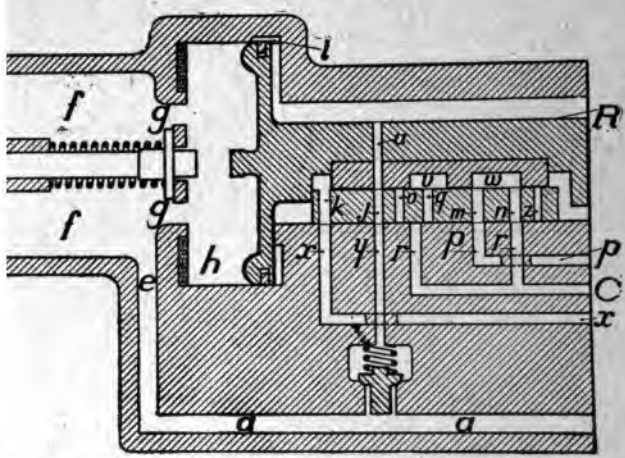


FIG. 15. THE T-2 TRIPLE VALVE



3. 16. THE T TRIPLE VALVE, RELEASE POSITION

OPERATION OF T 2 TRIPLE VALVE.

ing. Referring to Fig. 16. Air from the brake pipe enters valve through passage *a* and charges the auxiliary reser- vo separate channels: Through passages *a* and *e*, chamber ıber *h*, feed groove *i* into chamber R and the auxiliary

Also air in passage *a* raises the check valve and passes ports *y*, *j* and *u* to chamber R and the auxiliary reservoir. ıme time air from the control pipe passes through ports *x* chamber R and the auxiliary reservoir. With these three supplying air to the auxiliary reservoir simultaneously, ı pressure is obtained very quickly.

ate of charging the auxiliary reservoir through the three mentioned is such that a given volume of air can be re- the auxiliary reservoir in the same interval of time required xhaust of an equal amount from the brake cylinder to the re, thus maintaining an available maximum braking force ıes.

e Applications. The parts of the triple valve being in the hown in Fig. 16, a service reduction of brake-pipe pressure e piston and its slide valves toward the service position Fig. 17. When making this reduction, the check valve) its seat by its spring, preventing any back leakage of reservoir pressure to the brake pipe through this large port.

rst movement of the piston and graduating valve to the

left to GRADUATED-RELEASE-LAP position, parts *j* and *k* and the exhaust port in the main slide valve. During the further movement of the piston to service position, shown in Fig. 17, the closure of the ports mentioned is maintained by the graduating valve. When the slide and graduating valves are in service position, air flows from the auxiliary reservoir through port *z* and *r* to the brake cylinder and at the same time air in the brake pipe at *a* raises the check valve and flows through ports *y* and *o* into cavity *v* in the graduating valve, thence through ports *q* and *r* into the brake cylinder, thus producing a brake-pipe reduction at the same time that the auxiliary-reservoir pressure is flowing to the brake cylinder.

The relative capacity of the ports conducting air from the auxiliary reservior to the brake cylinder and from the brake pipe to the brake cylinder when the brake valve is lapped, is such that pressure in the auxiliary reservoir will reduce more rapidly than that in the brake pipe; therefore, it is impossible for the piston and graduating valve to remain in service position after the brake-pipe reduction to the atmosphere is stopped. When the auxiliary-reservoir pressure has been reduced to slightly less than that in the brake pipe, the piston moves the graduating valve to the right, closing service port *z* and quick-service port *o*, thus preventing any further flow of air to the brake cylinder until an additional reduction is made in the brake pipe. The piston and slide valves are now in "Service Lap" position as shown in Fig. 18.

Release. The piston being in service lap position, shown in Fig. 18, raising the brake-pipe pressure forces the piston, slide and gradu-

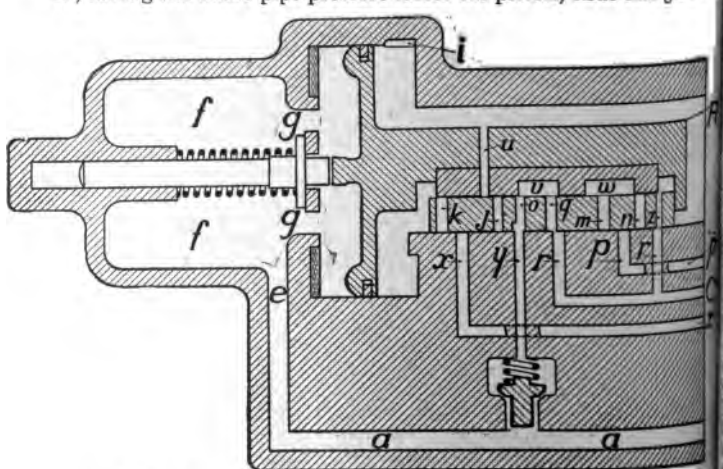
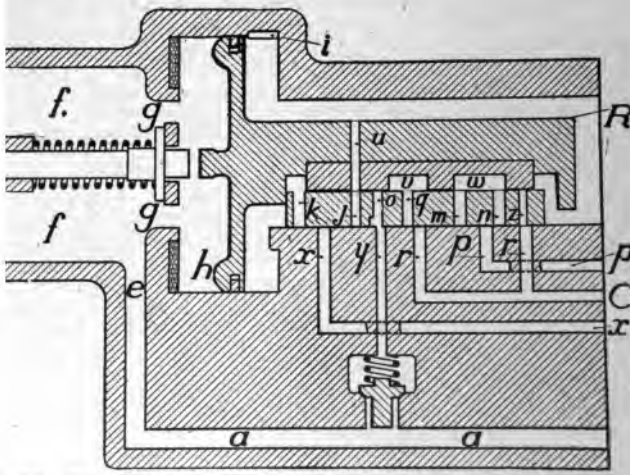


FIG. 17. THE T TRIPLE VALVE, SERVICE POSITION



18. THE T TRIPLE VALVE, SERVICE LAP POSITION

lves to the extreme right to release and charging position, ıe brake-cylinder pressure is exhausted, through ports *r* ıto cavity *w* in graduating valve, thence through ports *m* › the atmosphere. At the same time the auxiliary reser- ›ing recharged as described under the heading "Charging." e brake-valve handle is moved to release position and left ıe rise of brake-pipe pressure will be more rapid than that uxiliary reservoir, causing the piston to remain in release resulting in a full release of the brakes.

uated Release. If only sufficient air is permitted to flow brake-pipe to move the piston, slide and graduating valves e position, and the brake valve is then returned to lap, the ir from the control pipe through ports *x* and *k* to the auxili- ·voir will raise the latter pressure slightly above that in the pe and again move the piston and graduating valve to the RADUATED-RELEASE-LAP position, shown in Fig. 19, where uating valve has closed the exhaust port *m* from the brake to the atmosphere, port *j* from the brake pipe to the auxili- ·voir, and port *k* from the control pipe to the auxiliary reser- ıs retaining a portion of the pressure in the brake cylinder. ›ration of the triple valve is known as the "GRADUATED ›," and may be repeated until the brake-pipe pressure has ›reased to nearly its maximum. The amount of reduction ıre in the brake cylinder during graduated release depends › amount of increase of pressure in the brake-pipe.

Supplementary Reservoir. When a supplementary reservoir is used in place of the control pipe for the purpose of obtaining graduated release, its connection to the triple valve is made into port *x* as with the control pipe. With this system all the air passing to both the auxiliary reservoir and supplementary reservoir in charging is taken from the brake-pipe through feed groove *i* and ports *y*, *j* and *u*, into the auxiliary reservoir, thence down through ports *k* and *z* into the supplementary reservoir, which is charged to maximum auxiliary-reservoir pressure.

This passage connecting the two reservoirs, is open only when the triple valve is in release position; therefore, supplementary-reservoir pressure is retained while the brakes are applied. When the piston, slide valve and graduating valve are moved to release position, Fig. 16, again establishing communication between the two reservoirs through ports *x* and *k*, the back flow of air from the supplementary reservoir to the auxiliary reservoir moves the piston and graduating valve to "GRADUATED-RELEASE-LAP" position, Fig. 19, unless the brake-pipe pressure is raised more rapidly than that in the auxiliary reservoir. Consequently the graduated release is available and under the control of the operator substantially the same as when the control pipe is employed.

Emergency. When the brake-pipe pressure is reduced more rapidly than the auxiliary-reservoir pressure can reduce by flowing through service-application port *z* into the brake cylinder, the piston

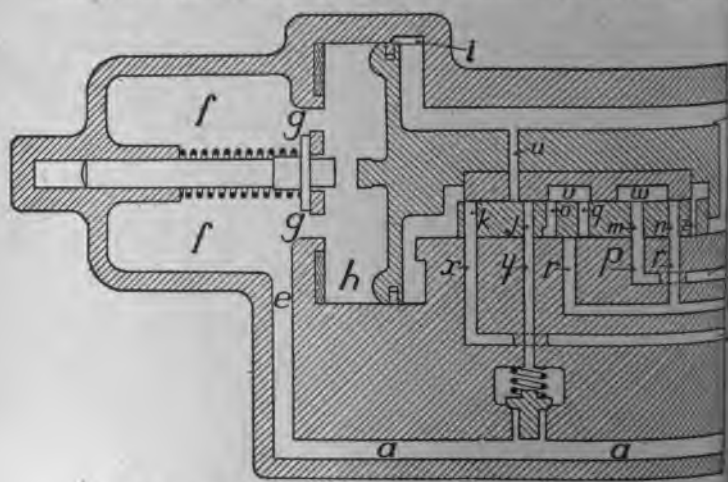


FIG. 19. THE T TRIPLE VALVE, GRADUATED-RELEASE LAP POSITION.

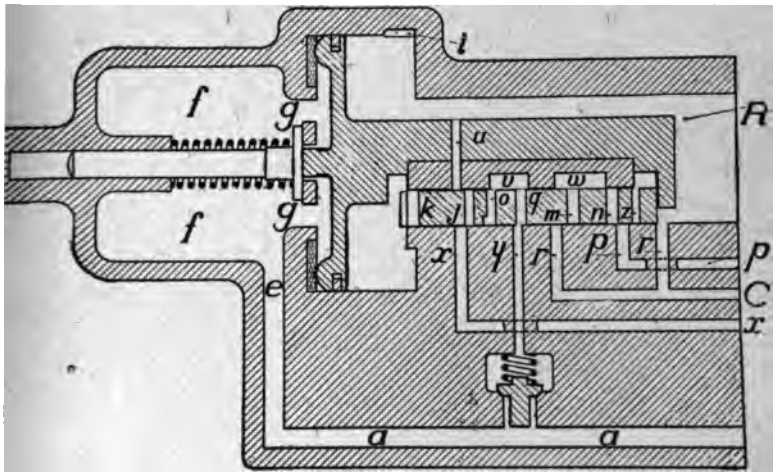


FIG. 20. THE T TRIPLE VALVE, EMERGENCY POSITION

compresses the graduating spring, moving with it the slide valve to emergency position shown in Fig. 20, where the large brake-cylinder port r is uncovered, permitting the brake to apply more quickly than is possible in service application.

TYPE M TRIPLE VALVE.

The type M triple valve is of the pipeless type and designed for use in high speed trains of from one to five cars. It is of the plain triple-valve type as represented by the F 1 (H 24) performs all the functions of this class of triple valve, and in addition several others as follows:

First—"Quick Recharge" of the auxiliary reservoir.
Second—"Quick Service" application of the brake.
Third—"Graduated Release" of the brake-cylinder pressure.
Fourth—"High Pressure Emergency" application.

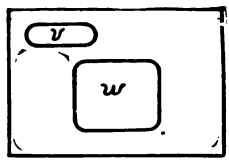
It requires the usual brake pipe, auxiliary reservoir, brake cylinder and exhaust connections; also an additional connection for either a control pipe or a supplementary reservoir.

Fig. 21 illustrates the triple valve complete.

Fig. 22 is a vertical cross-section of this valve in release position.

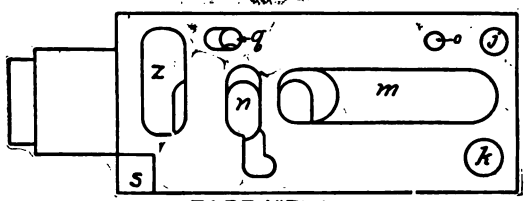
Fig. 23 shows the actual arrangement of ports and cavities in the graduating valve, slide valve and slide-valve bush.

Figs. 24, 25, 26, 27 and 28 are diagrammatic cuts showing the triple valve in its several positions.

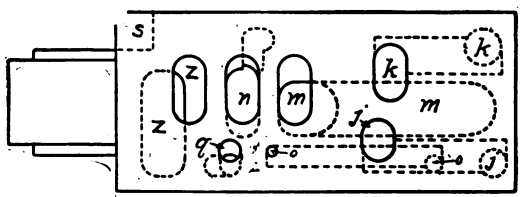


FACE VIEW

GRADUATING VALVE.

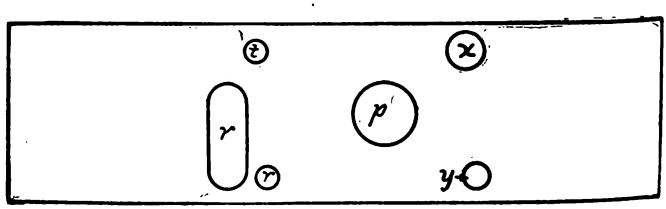


FACE VIEW



PLAN VIEW

SLIDE VALVE.



SLIDE VALVE SEAT.

FIG. 23. THE M-2 TRIPLE VALVE

Operation of the M 2 Triple Valve

Charging. Referring to Fig. 24. Air from the brake pipe enters the triple valve through passage *a*, *c* and *g* to chamber *h*, thence through feed groove *i* to chamber R and the auxiliary reservoir. Brake-pipe air in passage *a* also raises the check valve, passes through ports *y*, *j* and *u* into chamber R and the auxiliary reservoir. At the same time air from the control pipe enters the triple valve through passage *x* and flows through port *k* into chamber R and the auxiliary reservoir. With these three channels supplying air to the auxiliary reservoir simultaneously, maximum pressure is obtained very quickly.

The rate of charging the auxiliary reservoir through the three channels mentioned is such that a given volume of air can be restored in the auxiliary reservoir in the same interval of time required for the exhaust of an equal amount from the brake cylinder to the atmosphere, thus maintaining an available maximum braking force at all times.

Service Application. The parts of the triple valve being in charging position, shown in Fig. 24, a service reduction of brake-pipe pressure permits the auxiliary reservoir pressure to move the piston, slide and graduating valves to the left to service position, shown in Fig. 25. At the beginning of the service reduction, and before the slide or graduating valves have moved, the check valve in passage *y*, which is held to its seat by the light spring and auxiliary reservoir pressure, prevents any back flow of air from the reservoir to the brake pipe. The first movement of the piston closes feed groove *i*, and, carrying with it the graduating valve toward the application position, closes charging ports *k* and *j*, and the exhaust port *n*. With the slide and graduating valves in service position, shown

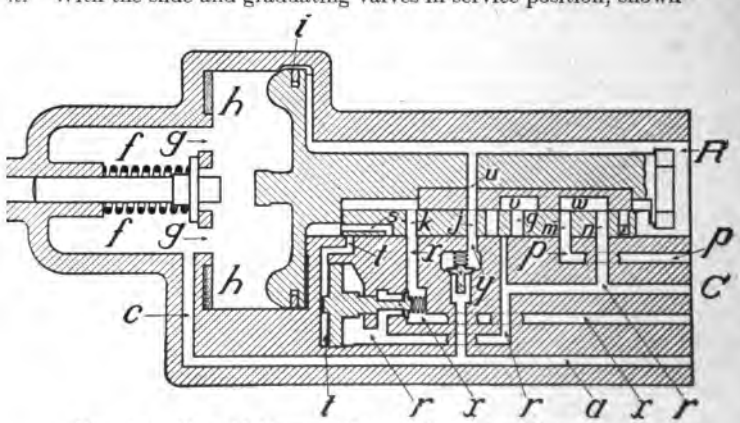


Fig. 24. The M Triple Valve, Release Position

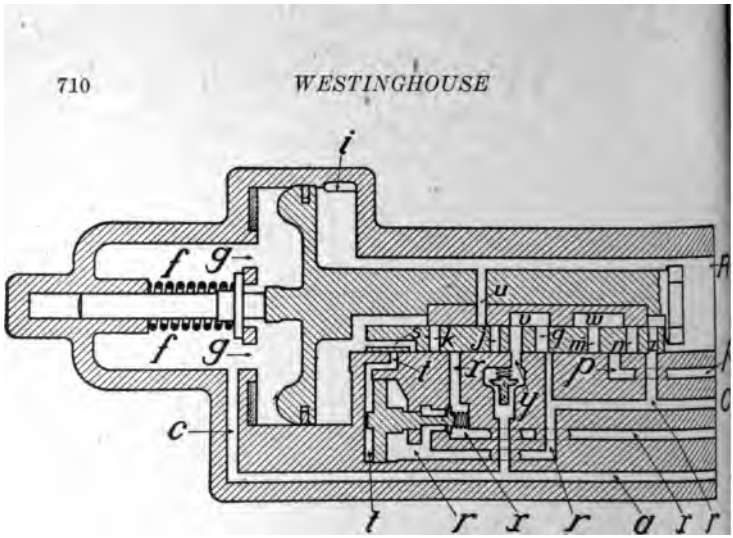


FIG. 25. THE M TRIPLE VALVE, SERVICE POSITION

in Fig. 25, air flows from the auxiliary reservoir through ports *z* and *r* to the brake cylinder. At the same time air in the brake-pipe passage *a* raises the check valve, flows through passage *y* into cavity *v* in the graduating valve, thence through ports *q* and *r* to the brake cylinder, thus producing a brake-pipe reduction at the same time that the auxiliary-reservoir air is flowing to the brake cylinder. This local reduction from the brake pipe to the brake cylinder produces what is known as the "QUICK-SERVICE" feature of the triple valve and results in a quick response of all triple valves to service reductions of brake-pipe pressure.

The relative capacity of the ports conducting the air from the auxiliary reservoir to the brake cylinder, and from the brake pipe to the brake cylinder, is such that the auxiliary-reservoir pressure will be reduced more rapidly than that in the brake pipe. It is, therefore, impossible for the piston and graduating valve to remain in service-application position after the brake-pipe reduction through the brake valve is stopped. If the brake-pipe reduction at the brake valve, added to that from the brake pipe to the brake cylinder passing through port *y*, cavity *v* and ports *q* and *r*, reduces the brake-pipe pressure more rapidly than the auxiliary-reservoir pressure can reduce by flowing through ports *z* and *r* to the brake cylinder, the triple-valve piston will be moved further to the left, carrying with it the slide valve. This further movement will cause a partial or complete closure of the quick-service ports *q* and *r*, thereby stopping the local brake-pipe reduction without reducing the capacity of ports *z* and *r* from the auxiliary reservoir to the brake cylinder, thus automatically guarding against the rate of brake-pipe reduction being so great as to cause undesired quick action.

When the flow of air from the auxiliary reservoir to the brake cylinder has reduced the pressure in the former to less than that in the brake pipe, the piston and graduating valve move to service-lap position, shown in Fig. 26, in which all ports are closed.

Release. The piston being in service-lap position, shown in Fig. 26, raising the brake-pipe pressure moves the piston, slide and graduating valve to the extreme right to release and charging position (Fig. 24), when the brake-cylinder pressure is exhausted through ports *r* and *n* into cavity *w* in the graduating valve, thence through ports *m* and *p*. At the same time the auxiliary reservoir is being recharged through the two charging ports *y* and *x* and feed groove *i* as described under the heading "Charging."

If the brake-valve handle is moved to release position and left there, the rise of brake-pipe pressure will be more rapid than that of the auxiliary reservoir, causing the piston to remain in release position, resulting in a full release of the brakes.

Graduated Release. If only sufficient air is permitted to flow into the brake pipe to move the piston, slide and graduating valves to release position (Fig. 24), and the brake valve is then returned to lap, the flow of air from the control pipe through ports *x* and *k* to the auxiliary reservoir will raise the pressure of the latter slightly above that in the brake pipe and move the piston and graduating valve to the left to "graduated-release-lap" position, shown in Fig. 27, where the graduating valve has closed the exhaust port *m* from the brake cylinder to the atmosphere, ports *x* and *k* from the control pipe to the auxiliary reservoir, and ports *y* and *j* from the brake pipe to the auxiliary reservoir, thus retaining a portion of the air pressure in the brake cylinder. This operation of the triple valve, "Gradu-

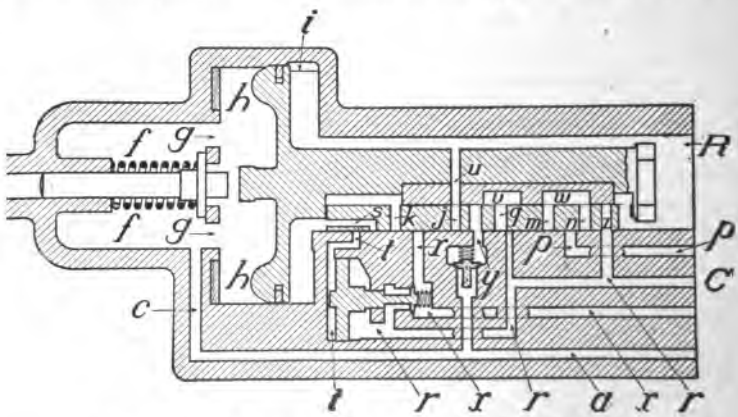


FIG 26. THE M TRIPLE VALVE, SERVICE LAP POSITION

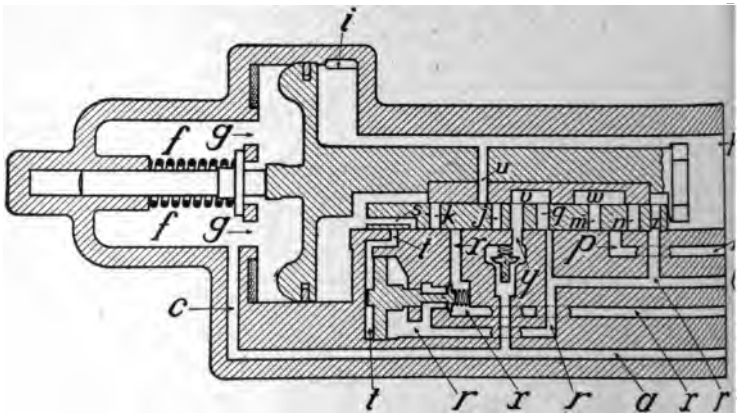


FIG. 25. THE M TRIPLE VALVE, SERVICE POSITION

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When the flow of air from the auxiliary reservoir to the brake cylinder has reduced the pressure in the former to less than that in the brake pipe, the piston and graduating valve move to service-lap position, shown in Fig. 26, in which all ports are closed.

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If the brake-valve handle is moved to release position and left there, the rise of brake-pipe pressure will be more rapid than that of the auxiliary reservoir, causing the piston to remain in release position, resulting in a full release of the brakes.

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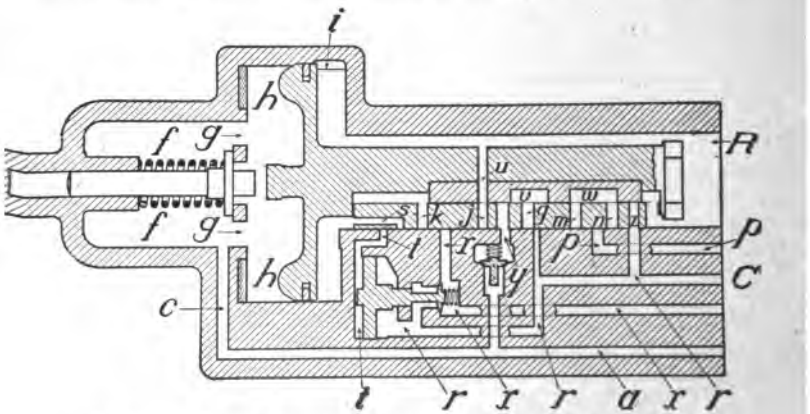


FIG 26. THE M TRIPLE VALVE, SERVICE LAP POSITION

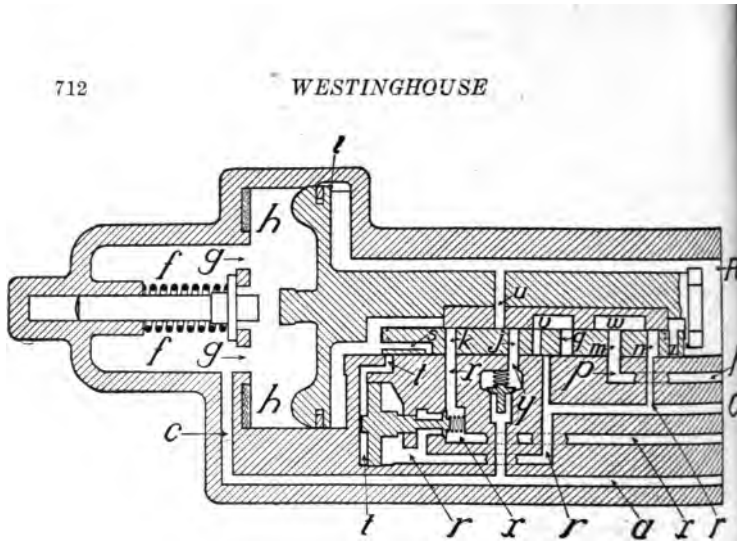


FIG. 27. THE M TRIPLE VALVE, GRADUATED-RELEASE-LAP POSITION

ated Release," may be repeated until the brake-pipe pressure has been increased to nearly its maximum. The amount of reduction in the brake cylinder during the graduated release depends upon the amount of increase of pressure in the brake pipe.

Supplementary Reservoir. When a supplementary reservoir is used in place of the control pipe for the purpose of obtaining graduated release, its connection to the triple valve is made into port *x* as with the control pipe. With this system all the air passing to both the auxiliary reservoir and supplementary reservoir in charging is taken from the brake pipe through feed groove *i* and ports *y*, *j* and *u*, into the auxiliary reservoir, thence down through ports *k* and *x* into the supplementary reservoir, which is charged to maximum auxiliary-reservoir pressure.

This passage connecting the two reservoirs is open only when the triple valve is in release position; therefore, supplementary-reservoir air is retained at its maximum pressure while the brakes are applied. When the piston, slide valve and graduating valve are moved to release position (Fig. 24), again establishing communication between the two reservoirs through ports *x* and *k*, the back flow of air from the supplementary reservoir to the auxiliary reservoir moves the piston and graduating valve to "graduated-release-lap" position (Fig. 27), unless the brake-pipe pressure is raised more rapidly than that in the auxiliary reservoir. Consequently the graduated release is available and under control of the operator substantially the same as when the control pipe is employed.

Emergency. When the brake-pipe pressure is reduced more rapidly than the air can flow from the auxiliary reservoir to the

brake cylinder through service-application port *z*, the piston compresses the graduating spring and moves through its extreme traverse to the left to emergency position (Fig. 28). Air from the auxiliary reservoir then flows past the end of the slide valve through port *r* into the brake cylinder. At the same time auxiliary-reservoir air flows through ports *s* and *t*, forces the "By-Pass Piston" to the right, opening the "By-Pass Valve." Air from the control pipe then flows through port *x*, *x*, past the by-pass valve through port *r*, *r* into the brake cylinder. When the auxiliary reservoir and brake-cylinder pressure becomes equal, air continues to flow from the control pipe and enters both the brake cylinder and auxiliary reservoir through port *r*. When the brake cylinder and auxiliary-reservoir pressure nearly equals that of the control pipe, the by-pass piston and by-pass valve are returned to their normal position by the valve spring, cutting off further communication from the control pipe and the auxiliary reservoir and brake cylinder. This action of the triple gives a much higher brake-cylinder pressure in emergency than is possible with standard quick-action triple valves.

The action of the triple valve in an emergency application is identical when installed with either a control pipe or a supplementary reservoir.

R 2 TRIPLE VALVE.

The R 2 triple valve is of the pipeless type and designed for trains of five or more cars, but is also used on trains consisting of less than five cars when the conditions of service are such that the number of cars per train may at times, or in the future, be increased to more than five cars. It is of the quick-action triple valve type such as

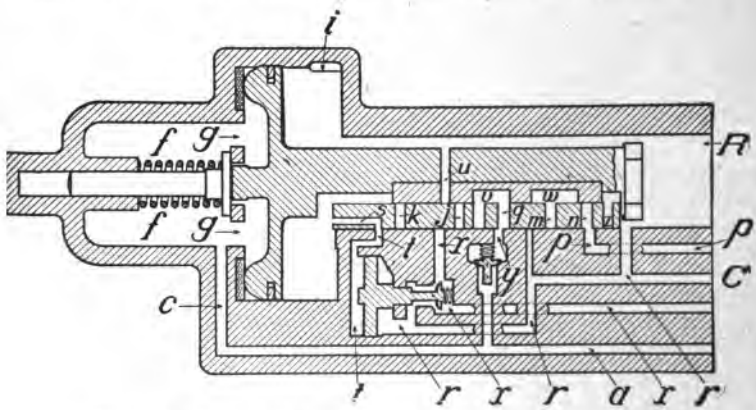


Fig. 28. The M Triple Valve, Emergency Position

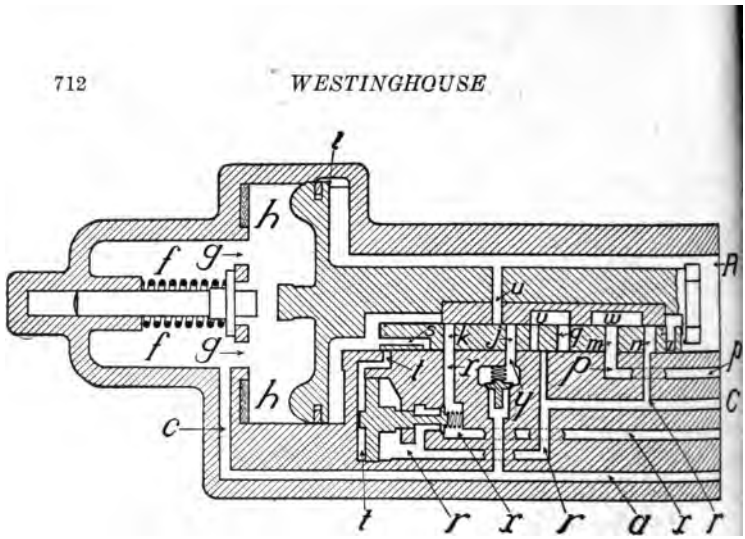


FIG. 27. THE M TRIPLE VALVE, GRADUATED-RELEASE-LAP POSITION

ated Release," may be repeated until the brake-pipe pressure has been increased to nearly its maximum. The amount of reduction in the brake cylinder during the graduated release depends upon the amount of increase of pressure in the brake pipe.

Supplementary Reservoir. When a supplementary reservoir is used in place of the control pipe for the purpose of obtaining graduated release, its connection to the triple valve is made into port *x* as with the control pipe. With this system all the air passing to both the auxiliary reservoir and supplementary reservoir in charging is taken from the brake pipe through feed groove *i* and ports *y*, *j* and *u*, into the auxiliary reservoir, thence down through ports *k* and *x* into the supplementary reservoir, which is charged to maximum auxiliary-reservoir pressure.

This passage connecting the two reservoirs is open only when the triple valve is in release position; therefore, supplementary-reservoir air is retained at its maximum pressure while the brakes are applied. When the piston, slide valve and graduating valve are moved to release position (Fig. 24), again establishing communication between the two reservoirs through ports *x* and *k*, the back flow of air from the supplementary reservoir to the auxiliary reservoir moves the piston and graduating valve to "graduated-release-lap" position (Fig. 27), unless the brake-pipe pressure is raised more rapidly than that in the auxiliary reservoir. Consequently the graduated release is available and under control of the operator substantially the same as when the control pipe is employed.

Emergency. When the brake-pipe pressure is reduced more rapidly than the air can flow from the auxiliary reservoir to the

brake cylinder through service-application port *z*, the piston compresses the graduating spring and moves through its extreme traverse to the left to emergency position (Fig. 28). Air from the auxiliary reservoir then flows past the end of the slide valve through port *r* into the brake cylinder. At the same time auxiliary-reservoir air flows through ports *s* and *t*, forces the "By-Pass Piston" to the right, opening the "By-Pass Valve." Air from the control pipe then flows through port *x*, *x*, past the by-pass valve through port *r*, *r* into the brake cylinder. When the auxiliary reservoir and brake-cylinder pressure becomes equal, air continues to flow from the control pipe and enters both the brake cylinder and auxiliary reservoir through port *r*. When the brake cylinder and auxiliary-reservoir pressure nearly equals that of the control pipe, the by-pass piston and by-pass valve are returned to their normal position by the valve spring, cutting off further communication from the control pipe and the auxiliary reservoir and brake cylinder. This action of the triple gives a much higher brake-cylinder pressure in emergency than is possible with standard quick-action triple valves.

The action of the triple valve in an emergency application is identical when installed with either a control pipe or a supplementary reservoir.

R 2 TRIPLE VALVE.

The R 2 triple valve is of the pipeless type and designed for trains of five or more cars, but is also used on trains consisting of less than five cars when the conditions of service are such that the number of cars per train may at times, or in the future, be increased to more than five cars. It is of the quick-action triple valve type such as

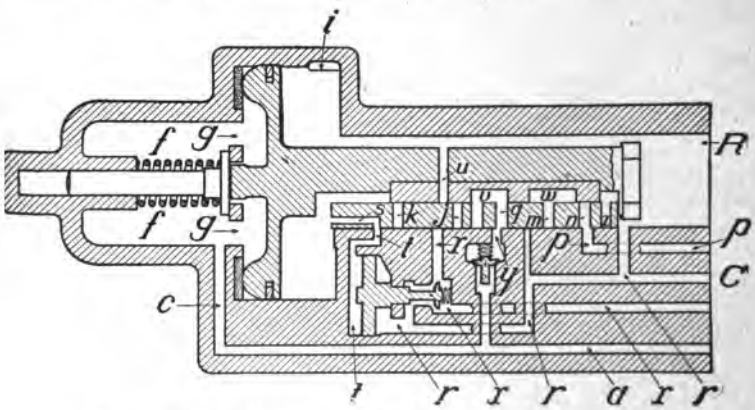


Fig. 28. The M Triple Valve, Emergency Position

FIG. 29. THE R-1 TRIPLE VALVE

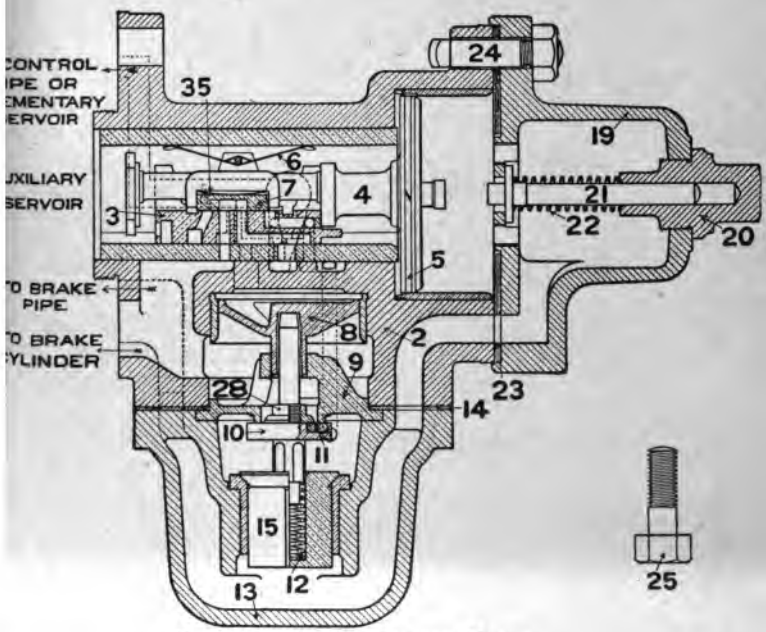


FIG. 30. THE R-2 TRIPLE VALVE

represented by the P 1 (F 27); performs all the functions of this class of triple valves, and in addition others, as follows:

First—"Quick Recharge" of the auxiliary reservoir.

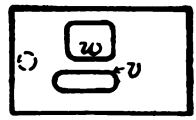
Second—"Quick Service" application of the brake.

Third—"Graduated Release" of the brake-cylinder pressure.

It requires the usual brake pipe, auxiliary reservoir, brake cylinder and exhaust connections, and an additional connection for either a control pipe or a supplementary reservoir. The use of the control pipe makes possible the graduation of the release, also an unlimited number of successive service applications without loss of braking power, such as results with the standard plain and quick-action triple valves. The control pipe-pressure is maintained equal to the maximum brake-pipe pressure by a feed valve located in the supply pipe from the main reservoir.

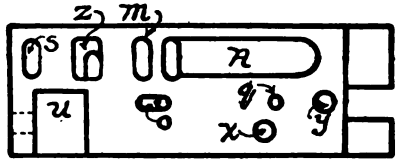
When a supplementary reservoir is used in place of the control pipe, graduated release can be obtained, and a number of brake applications made, without seriously depleting the braking power.

Fig. 29 is an illustration of the triple valve complete.

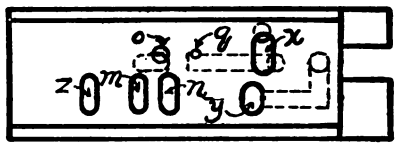


FACE VIEW

GRADUATING VALVE.

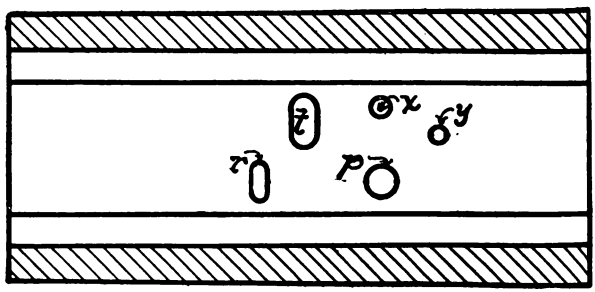


FACE VIEW



TOP VIEW

SLIDE VALVE.



SLIDE VALVE BUSH.

FIG. 31. THE R TRIPLE VALVE

Fig. 30 is a vertical cross section of the triple valve in release position.

Fig. 31 shows the actual arrangement of ports and cavities in the seat of the graduating valve, slide valve and slide-valve bush.

Figs. 32, 33, 34, 35 and 36 are diagrammatic cuts showing the triple valve in its several positions.

Operation of R 2 Triple Valve.

Charging. Referring to Fig. 32. Air from the brake pipe enters the triple valve at passage *a* and charges the auxiliary reservoir through two separate channels: Through passage *a*, *e*, *f* and *g*, chamber *h*, feed groove *i* and chamber R into the auxiliary reservoir; also from passage *a* past the check valve to chamber Y, thence through ports *y*, *j* and *u* into chamber R and the auxiliary reservoir. At the same time air from the control pipe enters the triple valve through passage *x* and flows through port *k* into chamber R and the

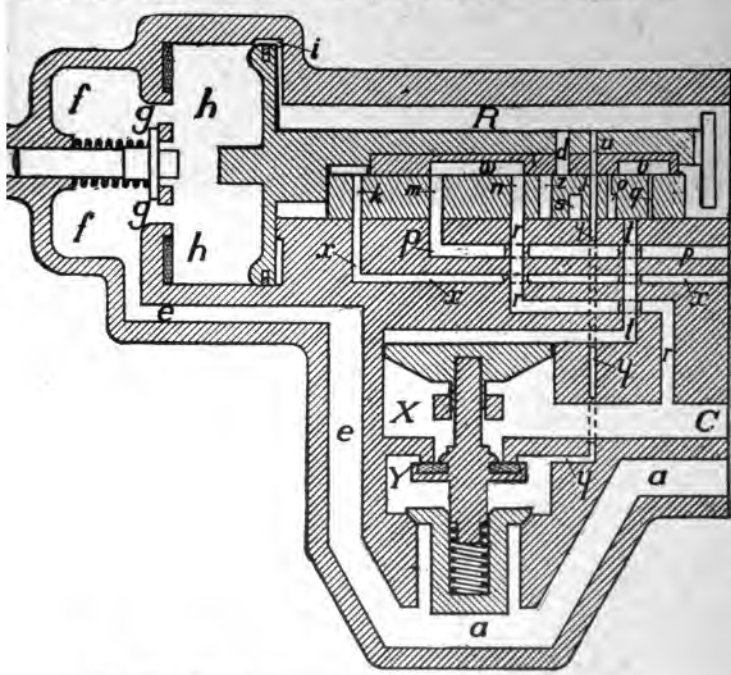


Fig. 32. The R Triple Valve, Release Position

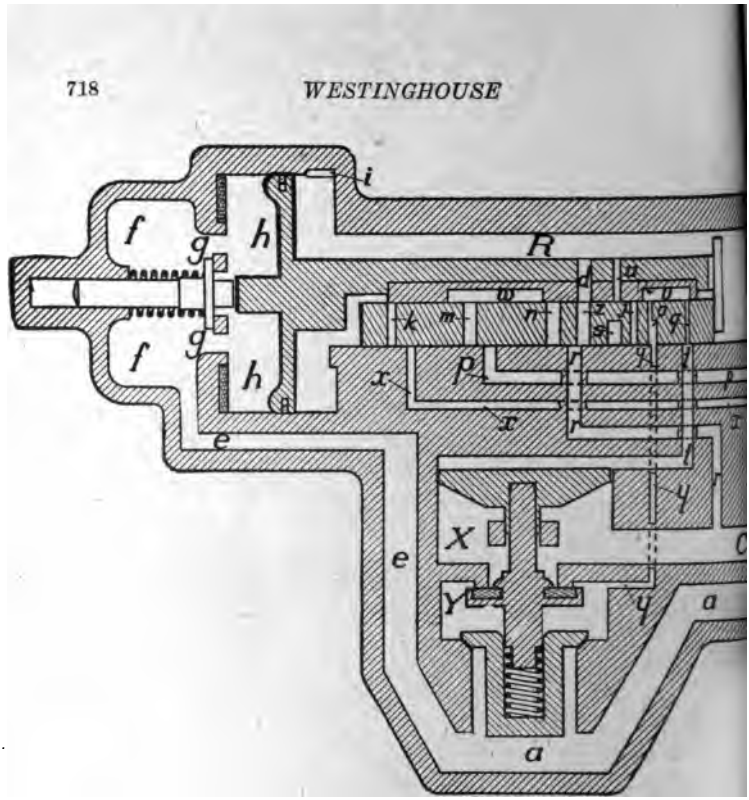


FIG. 33. THE R TRIPLE VALVE, SERVICE POSITION.

auxiliary reservoir. With these three channels supplying air to the auxiliary reservoir simultaneously, maximum pressure is obtained very quickly.

The rate of charging the auxiliary reservoir through the three channels mentioned is such that a given volume of air can be restored in the auxiliary reservoir in the same interval of time required for the exhaust of an equal amount from the brake cylinder to the atmosphere, thus maintaining an available maximum braking force at all times.

Service Application. The parts of the triple valve being in the position shown in Fig. 32, a service reduction of brake-pipe pressure moves the piston and slide valves toward the service position, shown in Fig. 33. When making this reduction, the check valve is held to its seat by the spring, preventing any back leakage of auxiliary-reservoir pressure to the brake pipe through this large charging port.

The first movement of the piston and graduating valve closes reed groove *i*, also charging ports *j* and *k* and the exhaust port *m* in the slide valve. During the further movement of the piston to service position, shown in Fig. 33, the closure of the ports mentioned is maintained by the graduating valve. When the slide and graduating valves are in service position, air flows from the auxiliary reservoir through ports *d*, *z* and *r* to the brake cylinder, and at the same time air in the brake pipe at *a* raises the check valve and flows through ports *y* and *o* into cavity *v* in the graduating valve, thence through ports *q* and *t* past the loosely fitted emergency piston into chamber X and the brake cylinder, thus producing a brake-pipe reduction at the same time that the auxiliary-reservoir pressure is flowing to the brake cylinder through port *z*.

The relative capacity of the ports conducting air from the brake pipe and auxiliary reservoir to the brake cylinder is such that the pressure in the auxiliary reservoir will reduce more rapidly than that

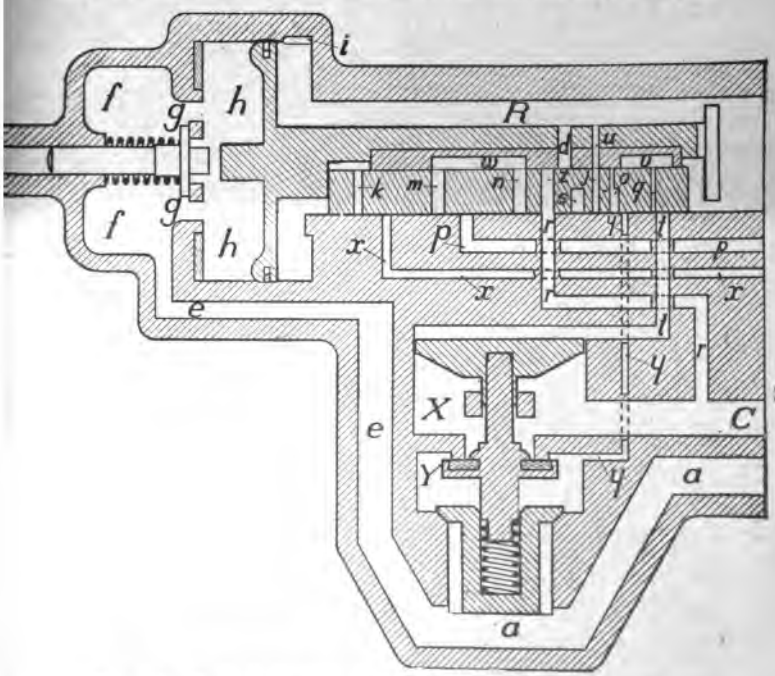


FIG. 34. THE R TRIPLE VALVE. SERVICE LAP POSITION

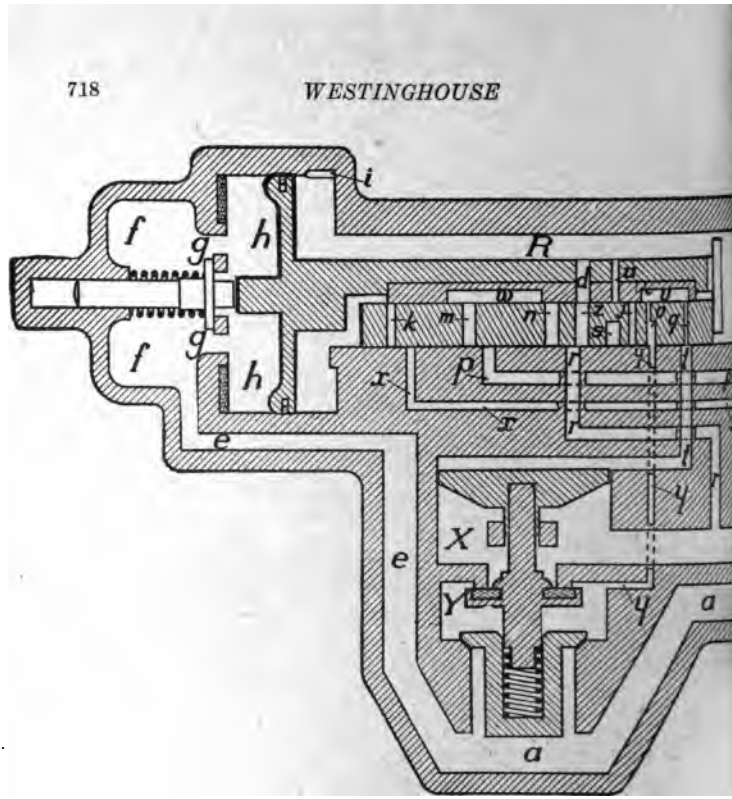


FIG. 33. THE R TRIPLE VALVE, SERVICE POSITION.

auxiliary reservoir. With these three channels supplying air to the auxiliary reservoir simultaneously, maximum pressure is obtained very quickly.

The rate of charging the auxiliary reservoir through the three channels mentioned is such that a given volume of air can be restored in the auxiliary reservoir in the same interval of time required for the exhaust of an equal amount from the brake cylinder to the atmosphere, thus maintaining an available maximum braking force at all times.

Service Application. The parts of the triple valve being in the position shown in Fig. 32, a service reduction of brake-pipe pressure moves the piston and slide valves toward the service position, shown in Fig. 33. When making this reduction, the check valve is held to its seat by the spring, preventing any back leakage of auxiliary-reservoir pressure to the brake pipe through this large charging port.

The first movement of the piston and graduating valve closes reed groove *i*, also charging ports *j* and *k* and the exhaust port *m* in the slide valve. During the further movement of the piston to service position, shown in Fig. 33, the closure of the ports mentioned is maintained by the graduating valve. When the slide and graduating valves are in service position, air flows from the auxiliary reservoir through ports *d*, *z* and *r* to the brake cylinder, and at the same time air in the brake pipe at *a* raises the check valve and flows through ports *y* and *o* into cavity *v* in the graduating valve, thence through ports *q* and *t* past the loosely fitted emergency piston into chamber X and the brake cylinder, thus producing a brake-pipe reduction at the same time that the auxiliary-reservoir pressure is flowing to the brake cylinder through port *z*.

The relative capacity of the ports conducting air from the brake pipe and auxiliary reservoir to the brake cylinder is such that the pressure in the auxiliary reservoir will reduce more rapidly than that

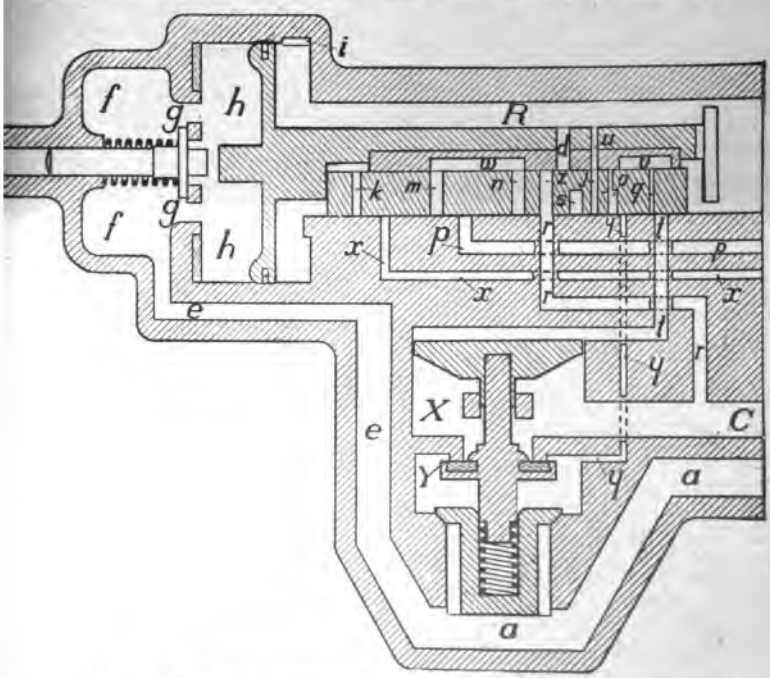


FIG. 34. THE R TRIPLE VALVE. SERVICE LAP POSITION

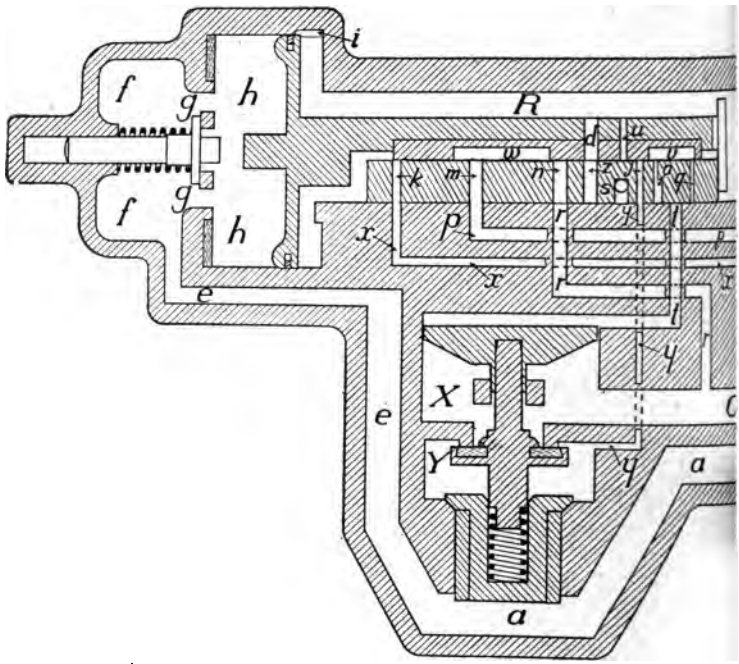


FIG 35. THE R TRIPLE VALVE, GRADUATED-RELEASE-LAP POSITION

in the brake pipe; therefore, it is impossible for the piston and graduating valve to remain in service position after the brake-pipe reductoin to the atmosphere is stopped. When the auxiliary-reservoir pressure has been reduced to slightly less than that in the brake pipe, the piston moves the graduating valve to the right and closes service port *z* and quick-service port *o*, thus preventing any further flow of air to the brake cylinder until an additional reduction is made in the brake pipe. The piston and slide valves are now in "Service-Lap" position (Fig. 34).

Release. The piston and slide valves being in service-lap position, shown in Fig. 34, raising the brake-pipe pressure above that in the auxiliary reservoir at R causes the movement of these parts to the right to release and charging position (Fig. 32). In this position air from the brake cylinder passes through ports *r* and *n* into cavity *w* in the graduating valve, thence through ports *m* and *p* to the

atmosphere. At the same time the auxiliary reservoir is being recharged from the brake pipe through ports *y*, *j* and *u* and the feed groove *i;* also from the control pipe through port *x* and *k* as previously described. In order to obtain a full and continuous exhaust from the brake cylinder, it is necessary to feed air into the brake pipe continuously until the maximum pressure has been obtained.

Graduated Release. If only sufficient air is permitted to flow into the brake pipe to move the piston, slide and graduating valves to release position (Fig. 32), and the brake valve is then returned to lap, the flow of air from the control pipe through ports *x* and *k* to the auxiliary reservoir will raise the latter pressure slightly above that in the brake pipe and move the piston and graduating valve to the left to "Graduated-Release-Lap" position (Fig. 35), where the graduating valve has closed both the exhaust port *m* from the brake cylinder to the atmosphere, and port *j* and the ports *x* and *k* from the control pipe to the auxiliary reservoir, thus retaining a

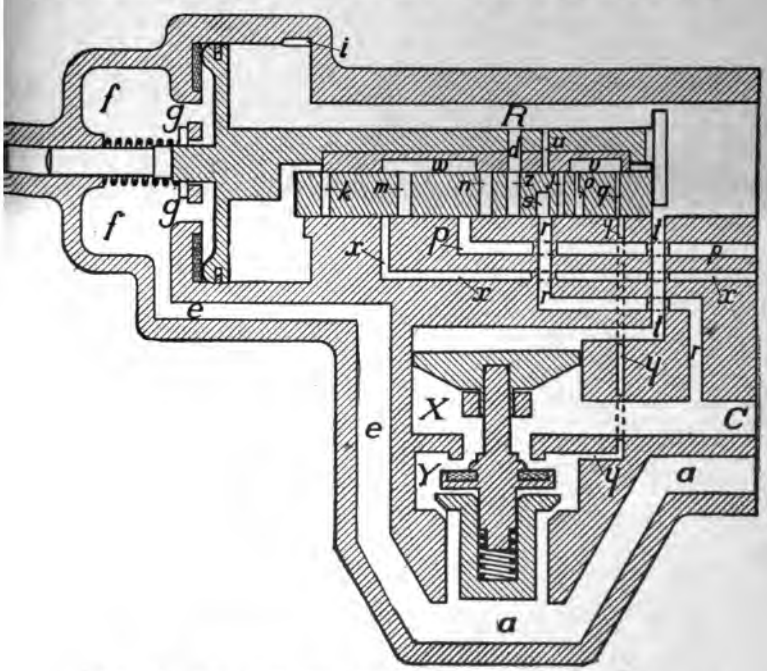


FIG. 36. THE R TRIPLE VALVE, EMERGENCY POSITION

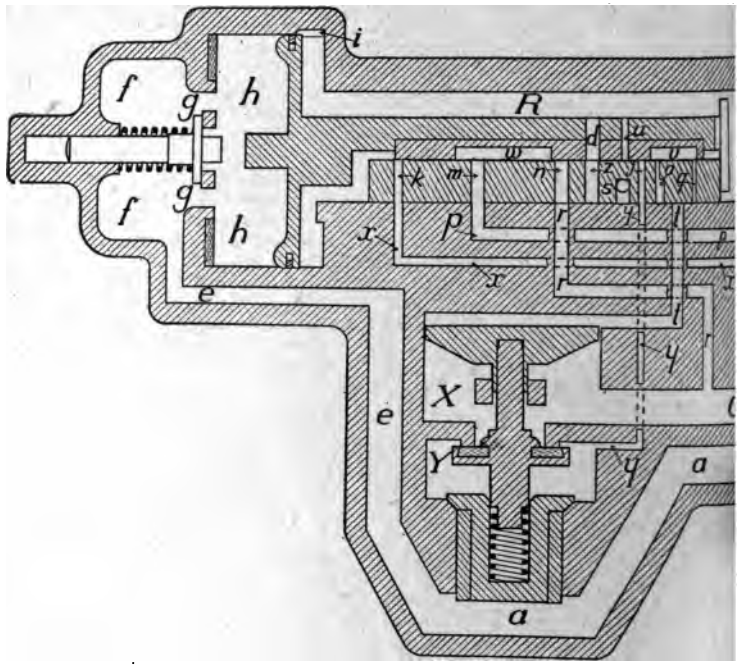


FIG 35. THE R TRIPLE VALVE, GRADUATED-RELEASE-LAP POSITION

in the brake pipe; therefore, it is impossible for the piston and graduating valve to remain in service position after the brake-pipe reductoin to the atmosphere is stopped. When the auxiliary-reservoir pressure has been reduced to slightly less than that in the brake pipe, the piston moves the graduating valve to the right and closes service port *z* and quick-service port *o*, thus preventing any further flow of air to the brake cylinder until an additional reduction is made in the brake pipe. The piston and slide valves are now in "Service-Lap" position (Fig. 34).

Release. The piston and slide valves being in service-lap position, shown in Fig. 34, raising the brake-pipe pressure above that in the auxiliary reservoir at R causes the movement of these parts to the right to release and charging position (Fig. 32). In this position air from the brake cylinder passes through ports *r* and *n* into cavity *w* in the graduating valve, thence through ports *m* and *p* to the

atmosphere. At the same time the auxiliary reservoir is being recharged from the brake pipe through ports *y*, *j* and *u* and the feed groove *i;* also from the control pipe through port *x* and *k* as previously described. In order to obtain a full and continuous exhaust from the brake cylinder, it is necessary to feed air into the brake pipe continuously until the maximum pressure has been obtained.

Graduated Release. If only sufficient air is permitted to flow into the brake pipe to move the piston, slide and graduating valves to release position (Fig. 32), and the brake valve is then returned to lap, the flow of air from the control pipe through ports *x* and *k* to the auxiliary reservoir will raise the latter pressure slightly above that in the brake pipe and move the piston and graduating valve to the left to "Graduated-Release-Lap" position (Fig. 35), where the graduating valve has closed both the exhaust port *m* from the brake cylinder to the atmosphere, and port *j* and the ports *x* and *k* from the control pipe to the auxiliary reservoir, thus retaining a

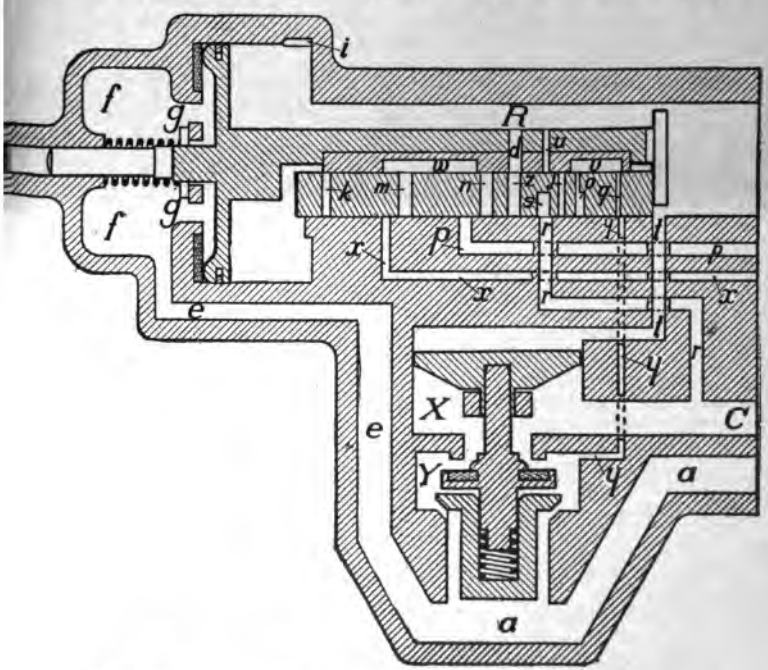


FIG. 36. THE R TRIPLE VALVE, EMERGENCY POSITION

portion of the pressure in the brake cylinder. This operation of the triple valve is known as the "Graduated Release" and may be repeated until the brake-pipe pressure has been increased to nearly its maximum. The reduction of brake-cylinder pressure during a graduated release depends upon the amount of increase of pressure in the brake pipe.

Supplementary Reservoir. The operation of the R 2 triple valve when installed with the supplementary reservoir in place of the control pipe operates as described under the same heading in the description of the T 2 triple valve.

Emergency Application. When a reduction of air pressure in the brake pipe reduces it more rapidly than the air can flow from the auxiliary reservoir to the brake cylinder through service application port *z*, the piston compresses the graduating spring and moves through its extreme traverse to the left to emergency position (Fig. 36). In this position air from the auxiliary reservoir flows through port *t* to the top of the emergency piston, forcing it downward and unseating the emergency valve Brake-pipe pressure in passage *a* then raises the check valve, passing through chamber Y past the emergency valve into chamber X and the brake cylinder. At the same time air from the auxiliary reservoir flows to the brake cylinder through tail port *s* and port *r* until the pressures in the auxiliary reservoir and brake cylinder are equal. This action, it will be noted, is identical with that of the standard quick-action triple valves and accomplishes the same results.

Q TRIPLE VALVES.

The Q type of triple valves are identical in internal construction and operation with the R triples above described, and only differ from them in having the arrangement of auxiliary reservoir and pipe connections the same as the standard quick-action triple valves.

TYPE L TRIPLE VALVE.

The L triple valve is of the pipeless type and designed for use in high-speed trains consisting of five or more cars, but should also be used on shorter trains when the conditions of service are such that the number of cars per train may at times, or in the future, be increased to more than five cars.

It is of the quick-action triple valve type, such as is represented by the P 1 (F 27); performs all of the functions of this class of triple, and in addition others, as follows:

First—"Quick Recharge" of the auxiliary reservoir.

Second—"Quick Service" application of the brake.

Third—"Graduated Release" of the pressure from the brake cylinder.

Fourth—"High Pressure Emergency" application

It requires the usual brake pipe, auxiliary reservoir, brake cylinder and exhaust connections, and an additional connection for either a control pipe or a supplementary reservoir.

Fig. 37 illustrates the triple valve complete.

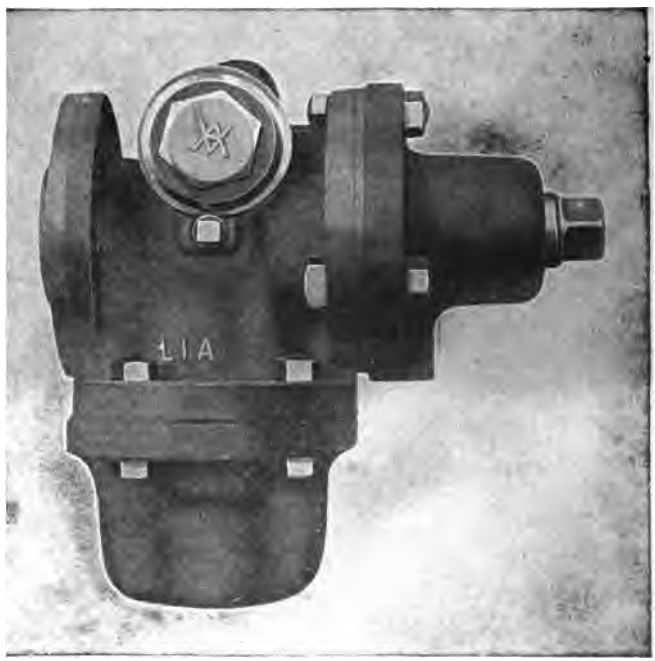


FIG. 37. THE L TRIPLE VALVE

Fig. 38 is a vertical cross section of the triple in release position.

Fig. 39 shows the actual arrangement of ports and cavities in the graduating valve, slide valve and slide-valve bush.

Figs. 40, 41, 42, 43 and 44 are diagrammatic cuts showing the triple valve in its several positions.

Operation of the L 2 Triple Valve.

Charging. Referring to Fig. 40. Air from the brake pipe enters the triple valve through passage *a*, *e*, *f* and *g* to chamber *h*, thence through feed groove *i* to chamber R and the auxiliary reservoir. Brake-pipe air in passage *a* also raises the check valve, passes through chamber Y, ports *y* and *j* into chamber R and the auxiliary reservoir. At the same time air from the control pipe enters the triple valve through passage *x* and flows from it through ports *x*, *k* and *y* into chamber R and the auxiliary reservoir. With these three channels supplying air simultaneously to the auxiliary reservoir, maximum pressure is obtained very quickly.

The rate of charging the auxiliary reservoir through the three channels mentioned is such that a given volume of air can be restored in the auxiliary reservoir in the same interval of time required for the exhaust of an equal amount from the brake cylinder to the atmosphere, thus maintaining an available maximum braking force at all times.

Service Application. The triple valve being in charging position, shown in Fig. 40, a service reduction of brake-pipe pressure permits the auxiliary-reservoir pressure to move the piston, slide and graduating valves to the left to service position, shown in Fig. 41.

At the beginning of the service reduction, and before the slide or graduating valves have moved, the check valve, which is held to its seat by its spring, prevents any back flow of air through port *y* from the auxiliary reservoir to the brake pipe.

The first movement of the piston closes feed groove *i*, and the graduating valve moving with it closes charging ports *k* and *j* and the exhaust port *p*. With the slide and graduating valves in service position, shown in Fig. 41, air flows from the auxiliary reservoir through ports *y*, *z* and *r* to the brake cylinder. At the same time air in the brake-pipe passage *a* raises the check valve, flows through chamber Y and ports *y* and *o* into cavity *v* in the graduating valve, thence through ports *q* and *r* to the brake cylinder, thus producing a brake-pipe reduction at the same time that the auxiliary-reservoir pressure is flowing to the brake cylinder. This local reduction from the brake pipe to the brake cylinder produces what is known as the "Quick-Service" feature and results in a quick response of all triple valves.

The relative capacity of the ports conducting the air from the auxiliary reservoir to the brake cylinder, and from the brake pipe to the brake cylinder, is such that the pressure in the auxiliary reservoir reduces more rapidly than that in the brake pipe. Therefore, when the brake valve is lapped, it is impossible for the piston and graduating valve to remain in service position. If the brake-pipe

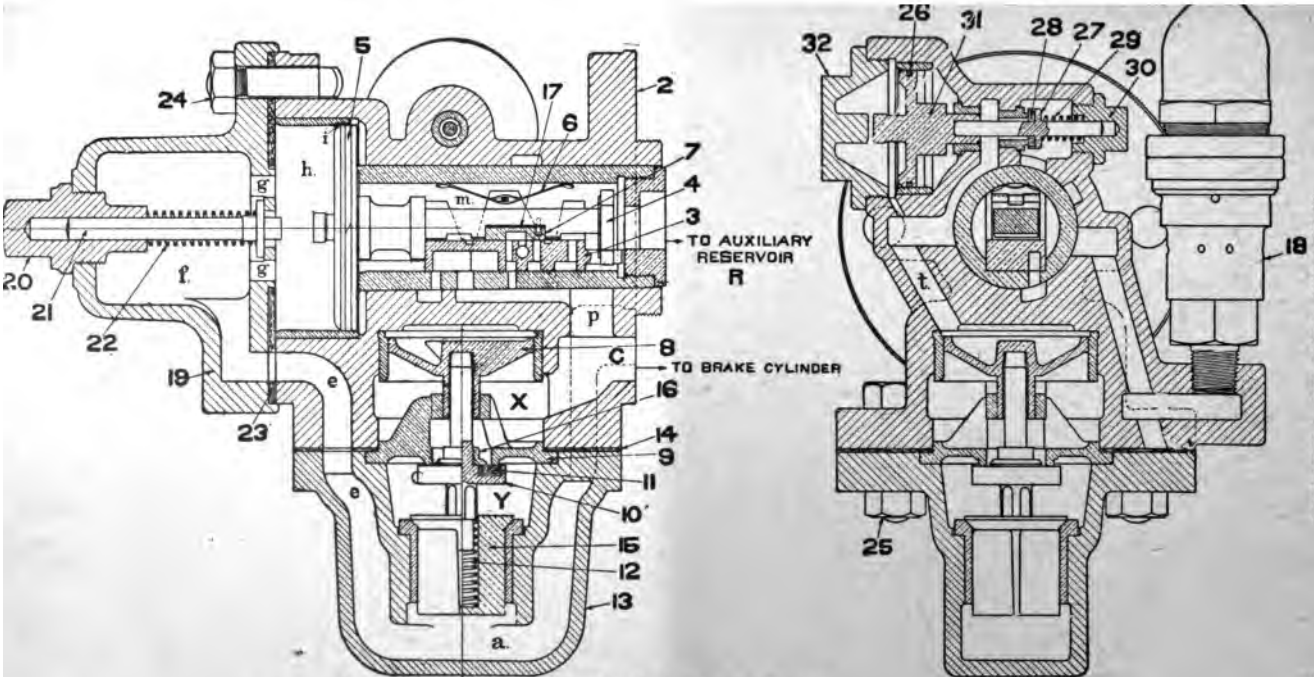


FIG. 38. THE L-2 TRIPLE VALVE

Fig. 38 is a vertical cross section of the triple in release position.

Fig. 39 shows the actual arrangement of ports and cavities in the graduating valve, slide valve and slide-valve bush.

Figs. 40, 41, 42, 43 and 44 are diagrammatic cuts showing the triple valve in its several positions.

Operation of the L 2 Triple Valve.

Charging. Referring to Fig. 40. Air from the brake pipe enters the triple valve through passage *a*, *e*, *f* and *g* to chamber *h*, thence through feed groove *i* to chamber R and the auxiliary reservoir. Brake-pipe air in passage *a* also raises the check valve, passes through chamber Y, ports *y* and *j* into chamber R and the auxiliary reservoir. At the same time air from the control pipe enters the triple valve through passage *x* and flows from it through ports *x*, *k* and *y* into chamber R and the auxiliary reservoir. With these three channels supplying air simultaneously to the auxiliary reservoir, maximum pressure is obtained very quickly.

The rate of charging the auxiliary reservoir through the three channels mentioned is such that a given volume of air can be restored in the auxiliary reservoir in the same interval of time required for the exhaust of an equal amount from the brake cylinder to the atmosphere, thus maintaining an available maximum braking force at all times.

Service Application. The triple valve being in charging position, shown in Fig. 40, a service reduction of brake-pipe pressure permits the auxiliary-reservoir pressure to move the piston, slide and graduating valves to the left to service position, shown in Fig. 41.

At the beginning of the service reduction, and before the slide or graduating valves have moved, the check valve, which is held to its seat by its spring, prevents any back flow of air through port *y* from the auxiliary reservoir to the brake pipe.

The first movement of the piston closes feed groove *i*, and the graduating valve moving with it closes charging ports *k* and *j* and the exhaust port *p*. With the slide and graduating valves in service position, shown in Fig. 41, air flows from the auxiliary reservoir through ports *y*, *z* and *r* to the brake cylinder. At the same time air in the brake-pipe passage *a* raises the check valve, flows through chamber Y and ports *y* and *o* into cavity *v* in the graduating valve, thence through ports *q* and *r* to the brake cylinder, thus producing a brake-pipe reduction at the same time that the auxiliary-reservoir pressure is flowing to the brake cylinder. This local reduction from the brake pipe to the brake cylinder produces what is known as the "Quick-Service" feature and results in a quick response of all triple valves.

The relative capacity of the ports conducting the air from the auxiliary reservoir to the brake cylinder, and from the brake pipe to the brake cylinder, is such that the pressure in the auxiliary reservoir reduces more rapidly than that in the brake pipe. Therefore, when the brake valve is lapped, it is impossible for the piston and graduating valve to remain in service position. If the brake-pipe

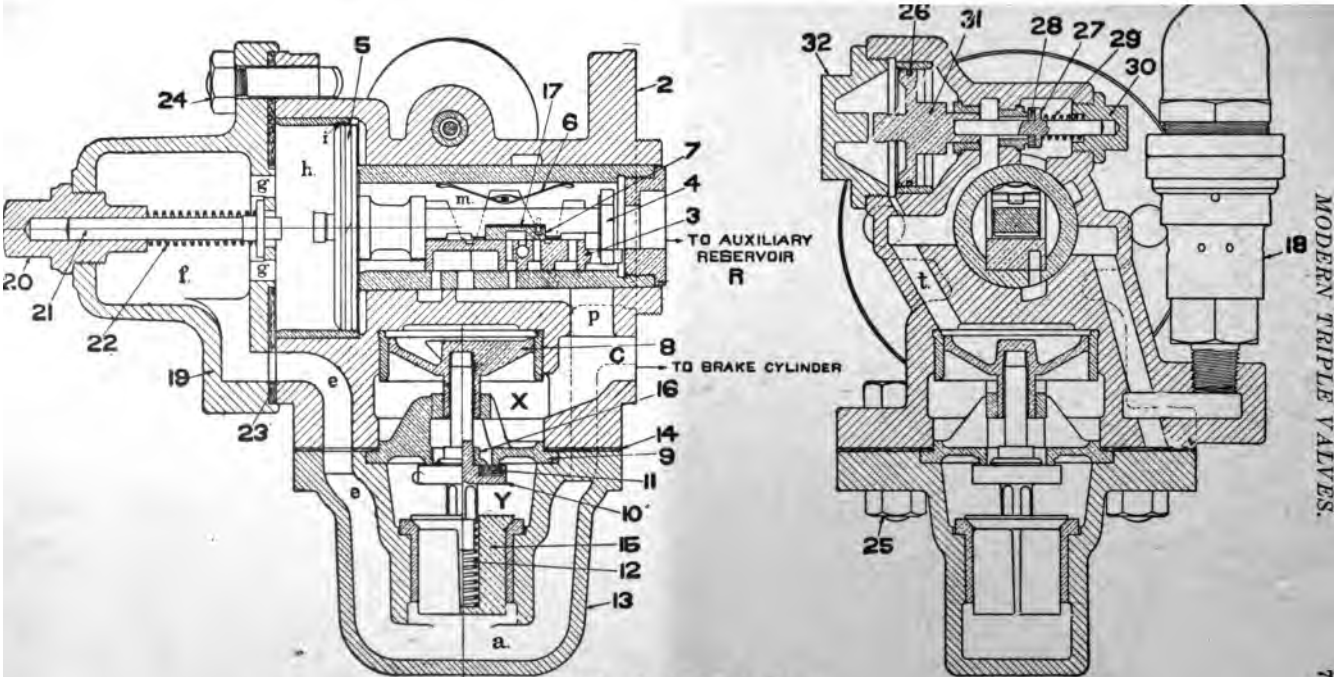
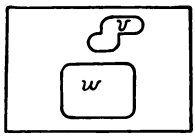
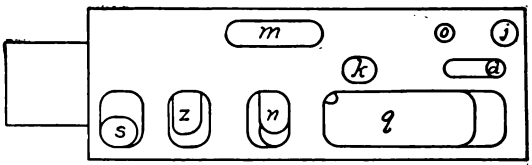


FIG. 38. THE L-2 TRIPLE VALVE

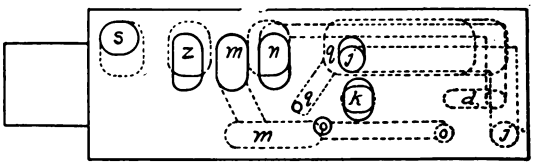


FACE VIEW

GRADUATING VALVE.

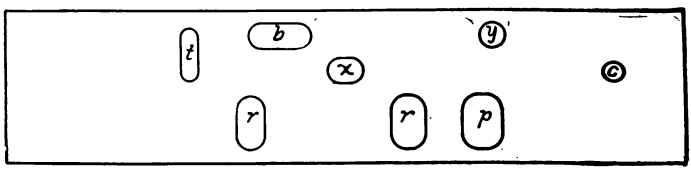


FACE VIEW



PLAN VIEW

SLIDE VALVE.



SLIDE VALVE SEAT.

FIG. 39. THE L-2 TRIPLE VALVE

tion at the brake valve and through chamber Y, ports *y* and *o*, *v*, ports *q* and *r* to the brake cylinder reduces the brake-pipe ire more rapidly than the auxiliary-reservoir pressure can re- by flowing through ports *y*, *z* and *r* to the brake cylinder, the -valve piston will move further to the left, carrying with it the valve. This further movement partially or completely closes uick-service port *y*, thereby automatically guarding against the of brake-pipe reduction being so great as to bring about unde- quick action.

hen the flow of air from the auxiliary reservoir to the brake ler has reduced the pressure in the former to less than that in

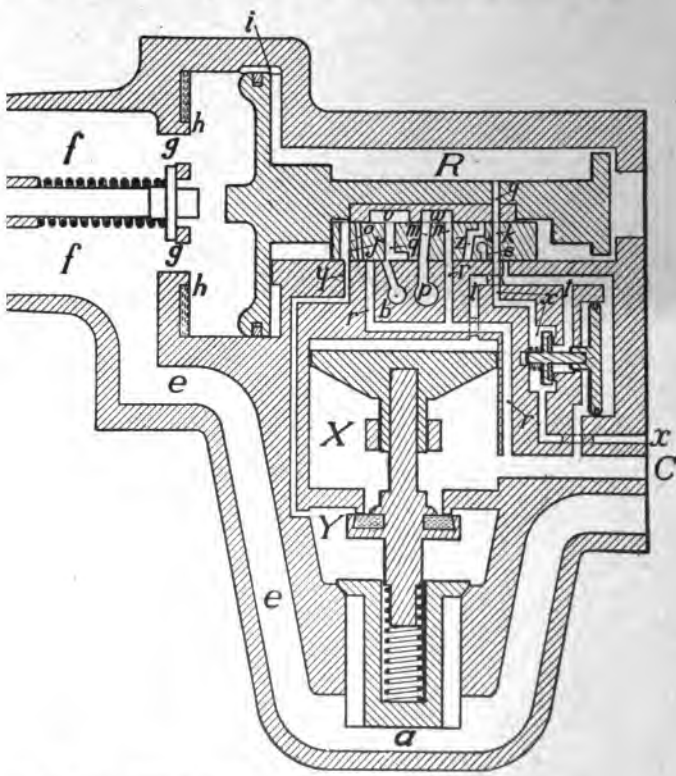


FIG. 40. THE L TRIPLE VALVE, RELEASE POSITION

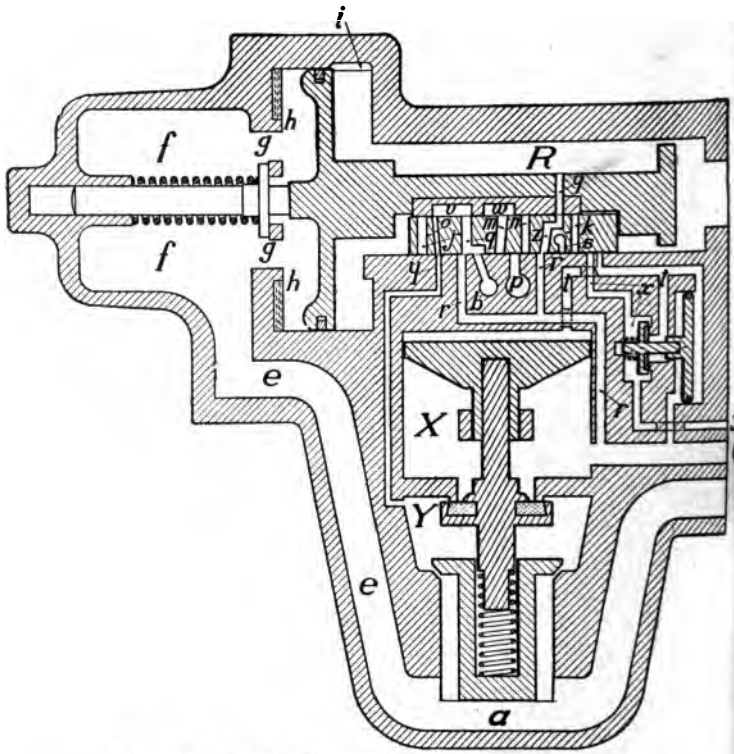


FIG. 41. THE L TRIPLE VALVE, SERVICE POSITION

the brake pipe, the brake-pipe pressure moves the piston and graduating valve to the right to service-lap position, shown in Fig. 42, where all ports through the slide valve are closed.

During service application, the brake is protected from excessive cylinder pressure by a safety valve connected to the outlet of port *b*. When the slide valve is in service position, communication is established from the brake cylinder to port *b* through port *r*, *r*, and the elongated lower end of port *q*; therefore, any surplus pressure in the brake cylinder during service application is immediately discharged to the atmosphere by the safety valve.

Release. The piston being in service-lap position, shown in Fig. 42, raising the brake-pipe pressure moves the piston, slide and gradu-

ating valve to the extreme right to release and charging position (Fig. 40), when brake-cylinder pressure is exhausted through ports *r* and *n* into cavity *w* in the graduating valve, thence through ports *m* and *p*. At the same time the auxiliary reservoir is being recharged through the three channels described under the heading "Charging."

If the brake-valve handle is moved to release position and left there, the rise of brake-pipe pressure will be more rapid than that in the auxiliary reservoir causing the piston to remain in release position, resulting in a full release of the brake.

Graduated Release. When only sufficient air is permitted to flow into the brake pipe to move the piston, slide and graduating

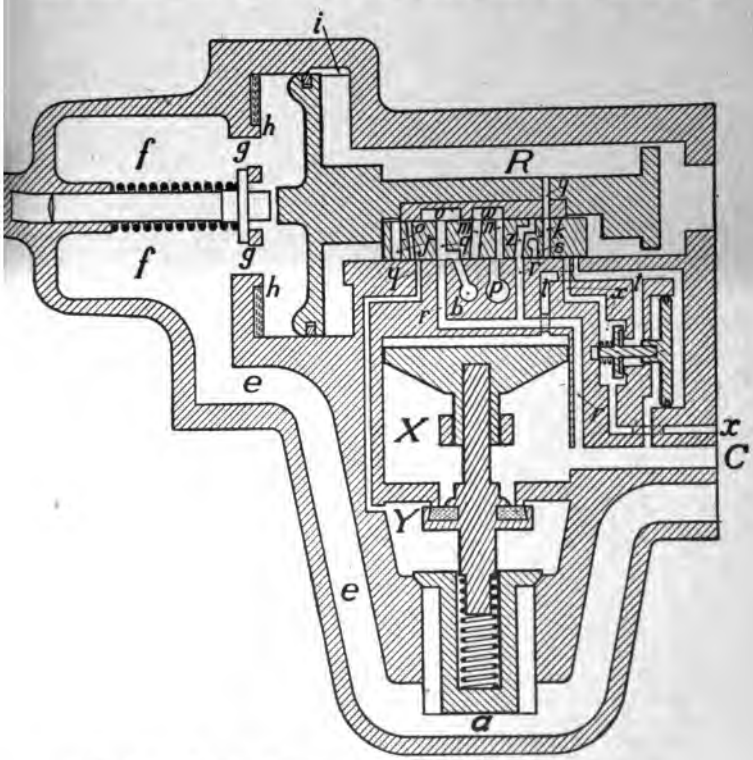


FIG. 42. THE L TRIPLE VALVE, SERVICE LAP POSITION

For the operation of these duplex regulating portions, three-way cocks are provided, being connected as shown in the piping diagram. To operate these cocks, turn the handle in line with the pipe leading to the regulating head to be used, high or low pressure as desired. This will cut in the head to regulate the supply portion, and cut off the pressure to the one not in use.

SCHEDULE B-3HS is the high speed brake. It includes the duplex pressure controller and the duplex pump governor. The regulating heads of the pressure controller should be adjusted to 70 pounds and 110 pounds for brake pipe pressure, and the pump governor heads adjusted to 90 pounds and 130 pounds for the main reservoir pressure. A union four-way cock is used with the regulating heads of the pressure controller. This is a special cock with a connection to each regulating top, one to the supply pipe, between the controller and brake valve, and one to the pipe between the brake valve and accelerator reservoir. When the handle of the four-way cock is in the position to operate the regulating head adjusted to 110 pounds brake pipe pressure, a small port in the accelerator reservoir connection is brought into communication with a port to the atmosphere. The object of this port is to prevent more than the usual predetermined reduction of brake pipe air, obtained in the graduating notches, taking place with 110 pounds pressure. A union three-way cock connected to the main reservoir and pump governor regulating tops is used to change the main reservoir pressures.

The piping diagrams of the four schedules of the B-3 equipment, shows the several parts comprising each schedule, as well as the proper pipe connections. This equipment is an improvement on former equipments. It not only includes all necessary features for the automatic brake, but also a straight air brake for the locomotive and tender, all operated by the automatic brake valve, without any additional positions.

Some of the notable improvements incorporated in the B-3 brake valve, which will be appreciated by those who come in contact with it, are: the use of tap bolts instead of screws to fasten the valve cover to the body; port O is cored in the valve body instead of being drilled through the cover; the projection for centering the piston packing leather EV 107 is on the piston instead of on the follower. A new packing leather can now be applied without removing the piston from the brake valve. It is only necessary to remove the back cap and the piston follower.

Other parts of the equipment fully described under their different headings are the 1¼″ pressure controller by which the brake pipe pressure is regulated; the accelerator valve which assists the brake valve in discharging brake pipe air when making service applications with long trains, the ¾″ controller which controls the straight air brake pressure; the high speed controller which acts as a reducing valve for the driver and truck brake cylinders, the lever safety valve and the quick release valve.

MANIPULATION.

To apply the automatic brakes on the locomotive and train, move the handle of the brake valve to the graduating notch necessary to make the required brake pipe reduction.

To release both locomotive and train brakes, move the handle to Running and Straight air release position.

To release the train brakes and hold the locomotive brakes set, move the handle to Automatic release and Straight Air Application position.

To apply the locomotive brakes (Straight Air), move the handle to Full Automatic release and Straight Air Application position.

To release the locomotive brakes move the handle to Running and Straight Air release position.

To apply the brakes in an emergency, move the handle quickly to Emergency position and leave it there until the train stops.

In case the automatic brakes are applied by the bursting of a hose, the train parts, or a conductor's valve is opened, place the handle in Lap position to retain the main reservoir pressure.

To graduate off or entirely release the locomotive brakes while holding the train brakes applied, use the lever safety valve to make the required reduction.

The handle of the brake valve will be found to work freely and easily at all times, as the pressure on the main slide valve does not exceed the maximum brake pipe pressure.

The cylinder gauge will show at all times the pressure in the locomotive brake cylinder and should be observed in brake manipulations.

Where there are two or more locomotives in a train, cut-out cock No. 1 should be turned to close the brake pipe and the brake valve handle carried in Running and Straight Air release position on all locomotives except the one from which the brakes are operated.

In case it becomes necessary to cut out the Straight Air brake, close cut-out cock No. 3, located in the straight air pipe.

To cut out the automatic brake on the engine, close cut-out cock No. 6, located in the pipe connecting the triple valve with the double check valve. By locating the cut-out cock at this point the auxiliary reservoir will remain charged if the brake is cut out, and can be cut in immediately should it be so desired. This cut-out cock and also cut-out cock No. 3 are special; they are of the three-way pattern and when turned off drain the pipes leading to the double check valve, which insures the check valve remaining seated in the direction of the closed cock. If desired, cut-out cock No. 8 can be substituted for cock No. 6; the latter is, however, recommended.

The main reservoir cock No. 4 is to cut off the supply of air when removing any of the apparatus except the governor.

B-3 BRAKE VALVE.

The straight air controller is to limit the pressure in the driver, ck and tender brake cylinders for the straight air brake, and uld be adjusted to 40 pounds pressure.

Cut-out cocks Nos. 5, 6 and 7 are recommended when truck ke is used, their purpose being fully understood. Nos. 9 and can be added, if desired, so that the driver brake cylinders and ervoir can be cut out and engine truck brake operated by truck ke reservoir.

B-3 BRAKE VALVE.

Figure 1 is a longitudinal side section of the brake valve (Run- g position), showing the main slide valve EV 312, and how the duating valve EV 317 is controlled by the piston EV 311 and er EV 302, also port O in the back cap, closed by the vent ve, EV 180. This view also shows the different positions of the ke valve handle. Fig. 3 is a cross section through the valve ar view). Fig. 4 is a cross section through the main slide ve, EV 312. This view shows the main reservoir and brake e connection. It also shows the location of passage H, which neets the supplementary reservoir and chamber D, back of on EV 311, also port O drilled to the slide valve seat and ity R in the slide valve. Fig. 2 is a top view of the valve h the cover, slide valve and handle removed, showing the seat connections for the straight air and divided reservoir pipes. shows the opening through the slide valve seat to the brake ve chamber A, beneath the slide valve. B is a cavity back of slide valve seat, into which the air flows from the main reser- pipe, although all the space under the valve cover and above slide valve is known as chamber B. C is the exhaust passage. s through to the exhaust passage and is an exhaust port for straight air brake in running and straight air release positions, is also an exhaust port for the air from chamber D, through t O in the release, running and lap positions. Port T is to the elerator reservoir. Port W is to the passage H and the sup- nentary reservoir. The location of port O in the seat is also wn.

Port O is used for the purpose of venting air from chamber o the atmosphere, so as to permit piston EV 311 to return to normal position (Fig. 1), when releasing brakes. It runs from vent valve seat through the back cap, lengthwise through the y of the brake valve to a point shown in Fig. 4, thence up to seat of the slide valve. It is connected to the exhaust passage cavity R in the slide valve, and port V in the seat, in full re- se, running and lap positions.

Chamber D air is prevented from escaping to the atmosphere these positions by the vent valve EV 180 on the end of piston 311. Just before the slide valve reaches the first graduat- notch, it covers port O, so that when the piston moves forward

B-3 BRAKE VALVE.

The straight air controller is to limit the pressure in the driver, ck and tender brake cylinders for the straight air brake, and uld be adjusted to 40 pounds pressure.

Cut-out cocks Nos. 5, 6 and 7 are recommended when truck ke is used, their purpose being fully understood. Nos. 9 and can be added, if desired, so that the driver brake cylinders and ervoir can be cut out and engine truck brake operated by truck ke reservoir.

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Chamber D air is prevented from escaping to the atmosphere these positions by the vent valve EV 180 on the end of piston 311. Just before the slide valve reaches the first graduat- notch, it covers port O, so that when the piston moves forward

For the operation of these duplex regulating portions, three-way cocks are provided, being connected as shown in the piping diagram. To operate these cocks, turn the handle in line with the pipe leading to the regulating head to be used, high or low pressure as desired. This will cut in the head to regulate the supply portion, and cut off the pressure to the one not in use.

SCHEDULE B-3HS is the high speed brake. It includes the duplex pressure controller and the duplex pump governor. The regulating heads of the pressure controller should be adjusted to 70 pounds and 110 pounds for brake pipe pressure, and the pump governor heads adjusted to 90 pounds and 130 pounds for the main reservoir pressure. A union four-way cock is used with the regulating heads of the pressure controller. This is a special cock with a connection to each regulating top, one to the supply pipe, between the controller and brake valve, and one to the pipe between the brake valve and accelerator reservoir. When the handle of the four-way cock is in the position to operate the regulating head adjusted to 110 pounds brake pipe pressure, a small port in the accelerator reservoir connection is brought into communication with a port to the atmosphere. The object of this port is to prevent more than the usual predetermined reduction of brake pipe air, obtained in the graduating notches, taking place with 110 pounds pressure. A union three-way cock connected to the main reservoir and pump governor regulating tops is used to change the main reservoir pressures.

The piping diagrams of the four schedules of the B-3 equipment, shows the several parts comprising each schedule, as well as the proper pipe connections. This equipment is an improvement on former equipments. It not only includes all necessary features for the automatic brake, but also a straight air brake for the locomotive and tender, all operated by the automatic brake valve, without any additional positions.

Some of the notable improvements incorporated in the B-3 brake valve, which will be appreciated by those who come in contact with it, are: the use of tap bolts instead of screws to fasten the valve cover to the body; port O is cored in the valve body instead of being drilled through the cover; the projection for centering the piston packing leather EV 107 is on the piston instead of on the follower. A new packing leather can now be applied without removing the piston from the brake valve. It is only necessary to remove the back cap and the piston follower.

Other parts of the equipment fully described under their different headings are the 1¼″ pressure controller by which the brake pipe pressure is regulated; the accelerator valve which assists the brake valve in discharging brake pipe air when making service applications with long trains, the ¾″ controller which controls the straight air brake pressure; the high speed controller which acts as a reducing valve for the driver and truck brake cylinders, the lever safety valve and the quick release valve.

automatically close the service exhaust port F, and unseats vent
ve EV 180, chamber D air only gets to the face of the slide
ve. When the brake valve is placed in the full release, running
lap positions, air from chamber D flows through port O, cavity
and port V to the atmosphere until the pressure in chamber D
slightly below that in chamber A (brake pipe), when the brake
pe pressure being the greater it forces piston EV 311 to the po-
ion shown in Fig. 1, seating the vent valve, and preventing fur-
r escape of chamber D air.

EV 326 is a pipe bracket bolted to the side of the brake valve.
has two pipe connections, one to the main reservoir and the
ier to the brake cylinders. Dotted lines show the cored passage
m the main reservoir connection to port N, and from port E to
cylinder pipe connection.

Figure 5 shows the face of the slide valve. F and G are the
vice exhaust ports and are connected by a passage through the
ter of the slide valve. J and K are the emergency exhaust
rts connected by passages on each side of the central passage,
necting F and G. S is a small port connected by passage X to
elongated port Ac, which registers with port T in the seat in
the service application positions. P is a groove whose func-
n is to connect port W and the supplementary reservoir with
ake pipe pressure in release and running positions. L is a
ssage through which air passes from the main reservoir pipe to
brake cylinder pipe in straight air application position. R is
avity connecting ports E and V in the running and straight air
ease positions to release the straight air brake and O and V
release, running and lap positions. It also permits the partial
ening of port N to E in the last graduating notch and full open-
g in emergency position. Ports M are through the slide valve
d are for charging the brake pipe.

Main reservoir air, reduced to brake pipe pressure by the pres-
re controller, flows into chamber B. The slide valve EV 312
trols the flow of air from the main reservoir to the brake pipe
d from the brake pipe to the atmosphere. The brake pipe is
nected to chamber A. Discharge of brake pipe air to the
nosphere for service applications occurs through ports F and G
d exhaust passage C, but for emergency applications through
rts J and K and exhaust passage C. In full automatic release
sition air is free to pass from the main reservoir to the brake
pe through ports M, and past the end of the slide valve EV 312.
the running position ports M only are open betewen the main
servoir and brake pipe, but they are sufficiently large to permit
ease of train brakes. Small slide valve EV 317 is a cut-off or
aduating valve operated by piston EV 311 and lever EV 312.
service applications it automatically laps port F and stops the
scharge of brake pipe air when the brake pipe reduction corre-
onding to the service graduating notch in which the handle is
aced has been made. Piston EV 311, which is exposed on one

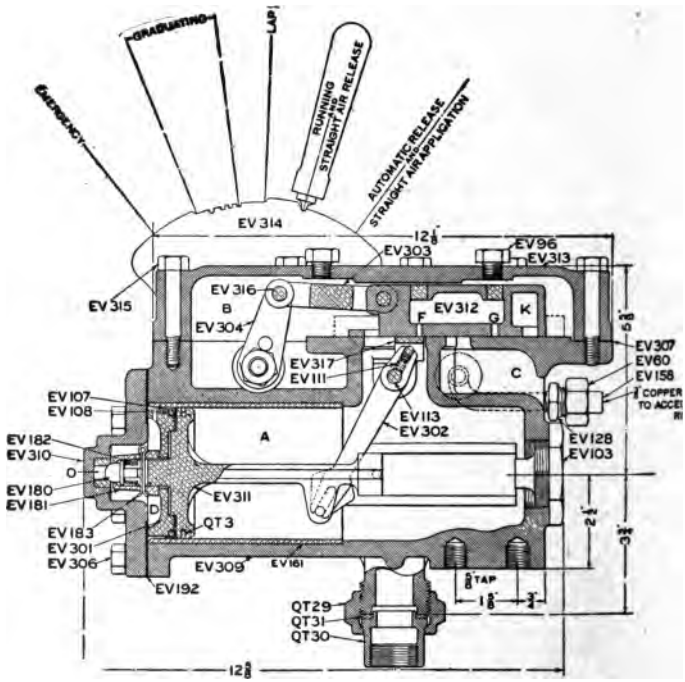
GRADUATING
LAP
RUNNING
STRAIGHT AIR RELEASE
AUTOMATIC RELEASE
STRAIGHT AIR APPLICATION
EMERGENCY
EV 314
EV 303
EV96
EV313
EV 315
EV 316
B
EV 304
F
EV 312
Q
K
EV 317
EV 111
C
EV307
EV60
EV158
EV 107
EV 108
EV 113
EV 302
EV128
EV103
EV 182
EV 310
O
A
EV 180
EV 181
D
EV 311
QT 3
EV 183
EV 301
EV 306
EV 309
EV 161
EV 192
TAP
QT29
QT31
QT30

Fig. 1.

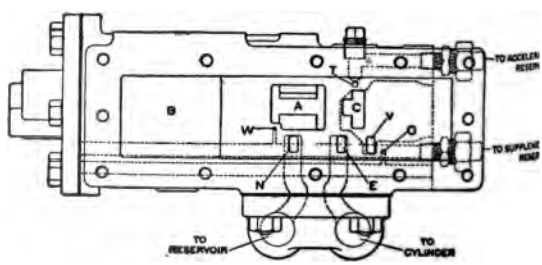
B
A
C
W
N
E
TO RESERVOIR
TO CYLINDER

Fig. 2.

natically close the service exhaust port F, and unseats vent V 180, chamber D air only gets to the face of the slide When the brake valve is placed in the full release, running ositions, air from chamber D flows through port O, cavity ort V to the atmosphere until the pressure in chamber D ly below that in chamber A (brake pipe), when the brake ssure being the greater it forces piston EV 311 to the po- own in Fig. 1, seating the vent valve, and preventing fur- ape of chamber D air.

326 is a pipe bracket bolted to the side of the brake valve. two pipe connections, one to the main reservoir and the the brake cylinders. Dotted lines show the cored passage e main reservoir connection to port N, and from port E to ader pipe connection.

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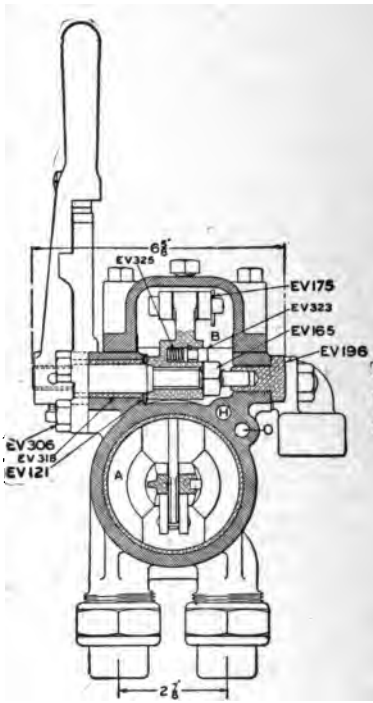

FIG. 3.

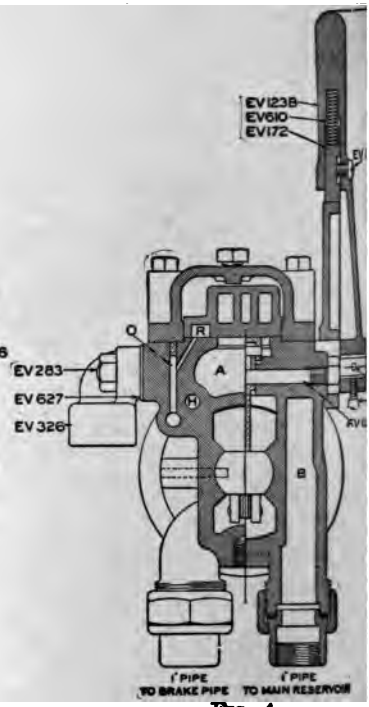

FIG. 4.

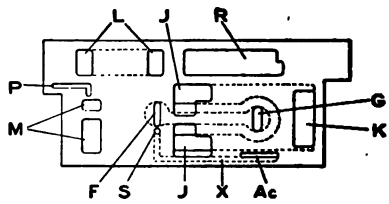

FIG. 5.

to brake pipe pressure and on the other to chamber D or sup-
nentary reservoir pressure, through the agency of lever EV 302
ses valve EV 317 to move automatically whatever distance is
essary to close port F.

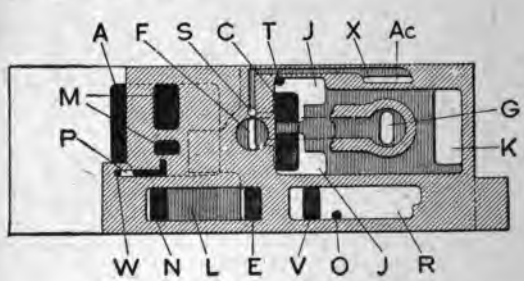

FIG. 6.

RELEASE POSITION.

AUTOMATIC RELEASE AND STRAIGHT AIR APPLICATION POSITION
g. 6). The purpose of this position is to promptly release
recharge the automatic brakes and to apply the straight air
kes or retain the pressure in the locomotive and tender brake
nders. In this position air flows directly from chamber B
ain reservoir), into chamber A (brake pipe), past the end of
slide valve and through ports M. Port O is open to the at-
phere through port V to permit piston EV 311 to return to its
mal position. Port T is open to the atmosphere through J and
The supplementary reservoir is being charged to brake pipe
ssure through groove P and port W from chamber A. Port E
brought into communication with port N by passage L, permit-
g air to pass to the locomotive and tender brake cylinders
ough the straight air pipe and double check valve until shut off
the ¾" pressure controller, the regulating top of which is con-
ted to the straight air pipe and adjusted at 40 pounds. By
cing the valve handle about midway between release and run-
g positions the straight air ports can be lapped, making it pos-
le to increase or decrease the brake cylinder pressure as may
necessary.

RUNNING POSITION.

RUNNING AND STRAIGHT AIR RELEASE POSITION (Fig. 7). This
the proper position in which to place the handle when
hing to release the train and locomotive brakes simultaneously,
to release the straight air brake when it only has been applied.

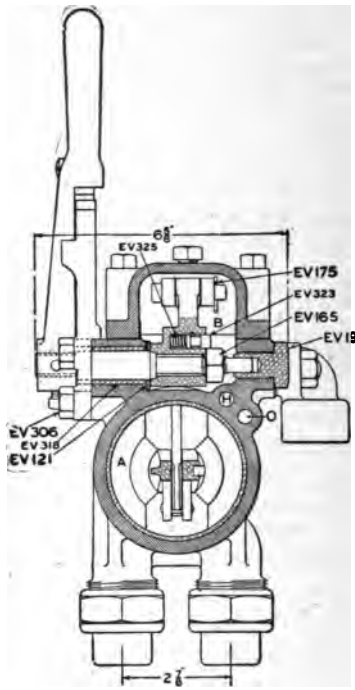

FIG. 3.

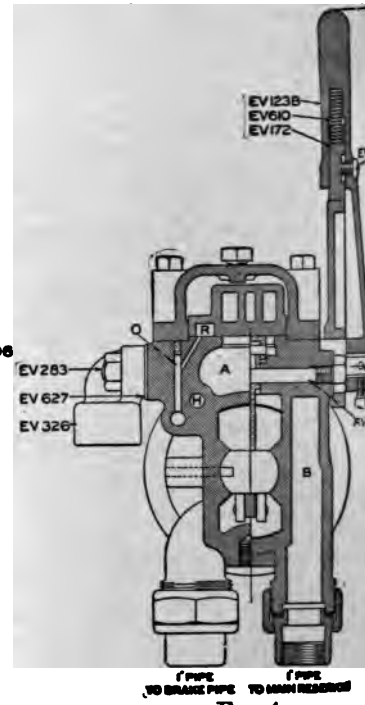

FIG. 4.

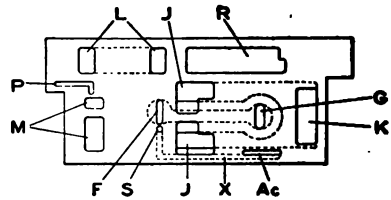

FIG. 5.

to brake pipe pressure and on the other to chamber D or supentary reservoir pressure, through the agency of lever EV 302 s valve EV 317 to move automatically whatever distance is sary to close port F.

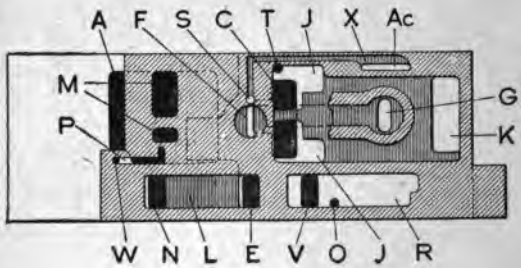

FIG. 6.

RELEASE POSITION.

UTOMATIC RELEASE AND STRAIGHT AIR APPLICATION POSITION . 6). The purpose of this position is to promptly release recharge the automatic brakes and to apply the straight air es or retain the pressure in the locomotive and tender brake ders. In this position air flows directly from chamber B n reservoir), into chamber A (brake pipe), past the end of lide valve and through ports M. Port O is open to the athere through port V to permit piston EV 311 to return to its ial position. Port T is open to the atmosphere through J and The supplementary reservoir is being charged to brake pipe sure through groove P and port W from chamber A. Port E ought into communication with port N by passage L, permitair to pass to the locomotive and tender brake cylinders ugh the straight air pipe and double check valve until shut off he ¾" pressure controller, the regulating top of which is con-ed to the straight air pipe and adjusted at 40 pounds. By ing the valve handle about midway between release and run- positions the straight air ports can be lapped, making it pos- to increase or decrease the brake cylinder pressure as may ecessary.

RUNNING POSITION.

UNNING AND STRAIGHT AIR RELEASE POSITION (Fig. 7). This he proper position in which to place the handle when ing to release the train and locomotive brakes simultaneously,) release the straight air brake when it only has been applied.

For the operation of these duplex regulating portions, three-way cocks are provided, being connected as shown in the piping diagram. To operate these cocks, turn the handle in line with the pipe leading to the regulating head to be used, high or low pressure as desired. This will cut in the head to regulate the supply portion, and cut off the pressure to the one not in use.

SCHEDULE B-3HS is the high speed brake. It includes the duplex pressure controller and the duplex pump governor. The regulating heads of the pressure controller should be adjusted to 70 pounds and 110 pounds for brake pipe pressure, and the pump governor heads adjusted to 90 pounds and 130 pounds for the main reservoir pressure. A union four-way cock is used with the regulating heads of the pressure controller. This is a special cock with a connection to each regulating top, one to the supply pipe, between the controller and brake valve, and one to the pipe between the brake valve and accelerator reservoir. When the handle of the four-way cock is in the position to operate the regulating head adjusted to 110 pounds brake pipe pressure, a small port in the accelerator reservoir connection is brought into communication with a port to the atmosphere. The object of this port is to prevent more than the usual predetermined reduction of brake pipe air, obtained in the graduating notches, taking place with 110 pounds pressure. A union three-way cock connected to the main reservoir and pump governor regulating tops is used to change the main reservoir pressures.

The piping diagrams of the four schedules of the B-3 equipment, shows the several parts comprising each schedule, as well as the proper pipe connections. This equipment is an improvement on former equipments. It not only includes all necessary features for the automatic brake, but also a straight air brake for the locomotive and tender, all operated by the automatic brake valve, without any additional positions.

Some of the notable improvements incorporated in the B-3 brake valve, which will be appreciated by those who come in contact with it, are: the use of tap bolts instead of screws to fasten the valve cover to the body; port O is cored in the valve body instead of being drilled through the cover; the projection for centering the piston packing leather EV 107 is on the piston instead of on the follower. A new packing leather can now be applied without removing the piston from the brake valve. It is only necessary to remove the back cap and the piston follower.

Other parts of the equipment fully described under their different headings are the 1¼" pressure controller by which the brake pipe pressure is regulated; the accelerator valve which assists the brake valve in discharging brake pipe air when making service applications with long trains, the ¾" controller which controls the straight air brake pressure; the high speed controller which acts as a reducing valve for the driver and truck brake cylinders, the lever safety valve and the quick release valve.

MANIPULATION.

To apply the automatic brakes on the locomotive and train, move the handle of the brake valve to the graduating notch necessary to make the required brake pipe reduction.

To release both locomotive and train brakes, move the handle to Running and Straight air release position.

To release the train brakes and hold the locomotive brakes set, move the handle to Automatic release and Straight Air Application position.

To apply the locomotive brakes (Straight Air), move the handle to Full Automatic release and Straight Air Application position.

To release the locomotive brakes move the handle to Running and Straight Air release position.

To apply the brakes in an emergency, move the handle quickly to Emergency position and leave it there until the train stops.

In case the automatic brakes are applied by the bursting of a hose, the train parts, or a conductor's valve is opened, place the handle in Lap position to retain the main reservoir pressure.

To graduate off or entirely release the locomotive brakes while holding the train brakes applied, use the lever safety valve to make the required reduction.

The handle of the brake valve will be found to work freely and easily at all times, as the pressure on the main slide valve does not exceed the maximum brake pipe pressure.

The cylinder gauge will show at all times the pressure in the locomotive brake cylinder and should be observed in brake manipulations.

Where there are two or more locomotives in a train, cut-out cock No. 1 should be turned to close the brake pipe and the brake valve handle carried in Running and Straight Air release position on all locomotives except the one from which the brakes are operated.

In case it becomes necessary to cut out the Straight Air brake, close cut-out cock No. 3, located in the straight air pipe.

To cut out the automatic brake on the engine, close cut-out cock No. 6, located in the pipe connecting the triple valve with the double check valve. By locating the cut-out cock at this point the auxiliary reservoir will remain charged if the brake is cut out, and can be cut in immediately should it be so desired. This cut-out cock and also cut-out cock No. 3 are special; they are of the three-way pattern and when turned off drain the pipes leading to the double check valve, which insures the check valve remaining seated in the direction of the closed cock. If desired, cut-out cock No. 8 can be substituted for cock No. 6; the latter is, however, recommended.

The main reservoir cock No. 4 is to cut off the supply of air when removing any of the apparatus except the governor.

B-3 BRAKE VALVE.

The straight air controller is to limit the pressure in the driver, ck and tender brake cylinders for the straight air brake, and uld be adjusted to 40 pounds pressure.

Cut-out cocks Nos. 5, 6 and 7 are recommended when truck ke is used, their purpose being fully understood. Nos. 9 and can be added, if desired, so that the driver brake cylinders and ervoir can be cut out and engine truck brake operated by truck ke reservoir.

B-3 BRAKE VALVE.

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Port O is used for the purpose of venting air from chamber to the atmosphere, so as to permit piston EV 311 to return to normal position (Fig. 1), when releasing brakes. It runs from vent valve seat through the back cap, lengthwise through the ly of the brake valve to a point shown in Fig. 4, thence up to seat of the slide valve. It is connected to the exhaust passage cavity R in the slide valve, and port V in the seat, in full re- se, running and lap positions.

Chamber D air is prevented from escaping to the atmosphere these positions by the vent valve EV 180 on the end of piston 311. Just before the slide valve reaches the first graduat- notch, it covers port O, so that when the piston moves forward

B-3 BRAKE VALVE.

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Port O is used for the purpose of venting air from chamber to the atmosphere, so as to permit piston EV 311 to return to normal position (Fig. 1), when releasing brakes. It runs from e vent valve seat through the back cap, lengthwise through the dy of the brake valve to a point shown in Fig. 4, thence up to e seat of the slide valve. It is connected to the exhaust passage cavity R in the slide valve, and port V in the seat, in full re- ase, running and lap positions.

Chamber D air is prevented from escaping to the atmosphere these positions by the vent valve EV 180 on the end of piston V 311. Just before the slide valve reaches the first graduat- g notch, it covers port O, so that when the piston moves forward

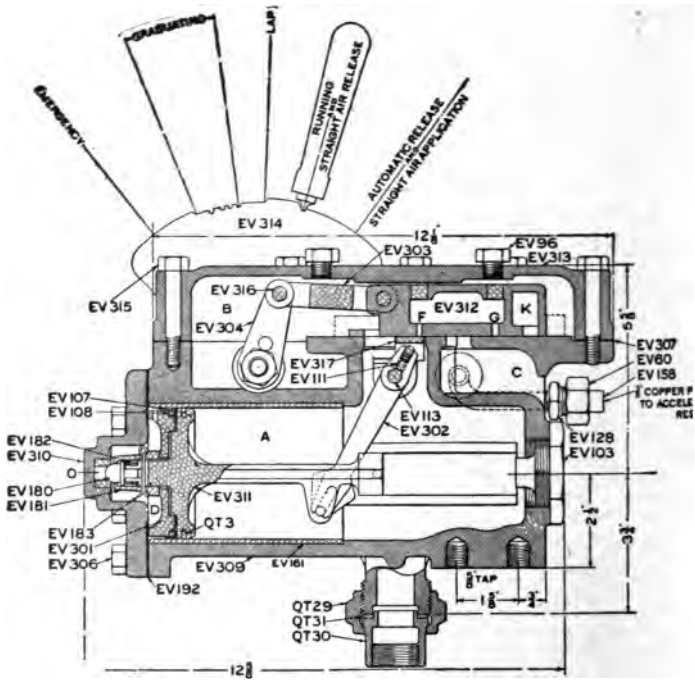

GRADUATING
LAP
RUNNING
STRAIGHT AIR RELEASE
AUTOMATIC RELEASE
AND
STRAIGHT AIR APPLICATION
EMERGENCY
EV 314
EV 303
EV 96
EV 313
EV 315
EV 316
B
EV 304
EV 312
F
G
K
EV 317
EV 111
C
EV 307
EV 60
EV 158
EV 107
EV 108
EV 113
EV 302
A
EV 182
EV 310
EV 180
EV 181
EV 311
QT 3
EV 183
EV 301
EV 306
EV 309
EV 161
EV 192
EV 128
EV 103
TAP
QT 29
QT 31
QT 30

Fig. 1.

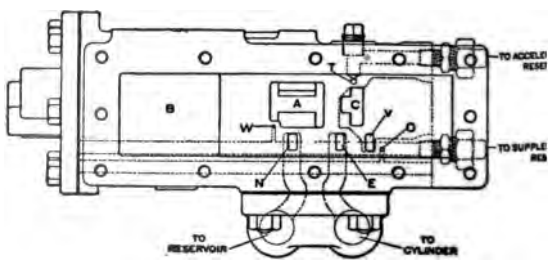

B
A
C
W
T
S
N
E
TO
RESERVOIR
TO
CYLINDER

Fig. 2.

to automatically close the service exhaust port F, and unseats vent valve EV 180, chamber D air only gets to the face of the slide valve. When the brake valve is placed in the full release, running or lap positions, air from chamber D flows through port O, cavity R and port V to the atmosphere until the pressure in chamber D is slightly below that in chamber A (brake pipe), when the brake pipe pressure being the greater it forces piston EV 311 to the position shown in Fig. 1, seating the vent valve, and preventing further escape of chamber D air.

EV 326 is a pipe bracket bolted to the side of the brake valve. It has two pipe connections, one to the main reservoir and the other to the brake cylinders. Dotted lines show the cored passage from the main reservoir connection to port N, and from port E to the cylinder pipe connection.

Figure 5 shows the face of the slide valve. F and G are the service exhaust ports and are connected by a passage through the center of the slide valve. J and K are the emergency exhaust ports connected by passages on each side of the central passage, connecting F and G. S is a small port connected by passage X to the elongated port Ac, which registers with port T in the seat in all the service application positions. P is a groove whose function is to connect port W and the supplementary reservoir with brake pipe pressure in release and running positions. L is a passage through which air passes from the main reservoir pipe to the brake cylinder pipe in straight air application position. R is a cavity connecting ports E and V in the running and straight air release positions to release the straight air brake and O and V in release, running and lap positions. It also permits the partial opening of port N to E in the last graduating notch and full opening in emergency position. Ports M are through the slide valve and are for charging the brake pipe.

Main reservoir air, reduced to brake pipe pressure by the pressure controller, flows into chamber B. The slide valve EV 312 controls the flow of air from the main reservoir to the brake pipe and from the brake pipe to the atmosphere. The brake pipe is connected to chamber A. Discharge of brake pipe air to the atmosphere for service applications occurs through ports F and G and exhaust passage C, but for emergency applications through ports J and K and exhaust passage C. In full automatic release position air is free to pass from the main reservoir to the brake pipe through ports M, and past the end of the slide valve EV 312. In the running position ports M only are open betewen the main reservoir and brake pipe, but they are sufficiently large to permit release of train brakes. Small slide valve EV 317 is a cut-off or graduating valve operated by piston EV 311 and lever EV 312. In service applications it automatically laps port F and stops the discharge of brake pipe air when the brake pipe reduction corresponding to the service graduating notch in which the handle is placed has been made. Piston EV 311, which is exposed on one

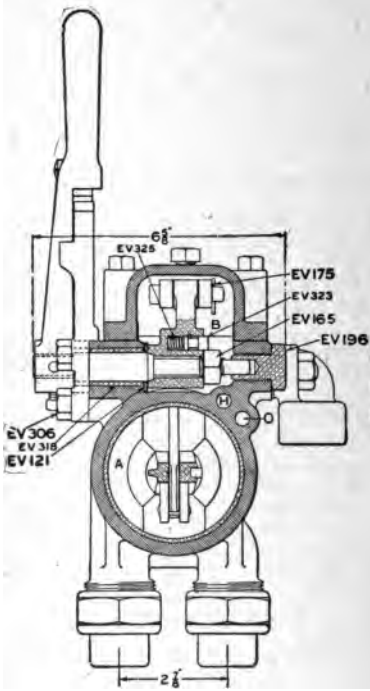


FIG. 3.

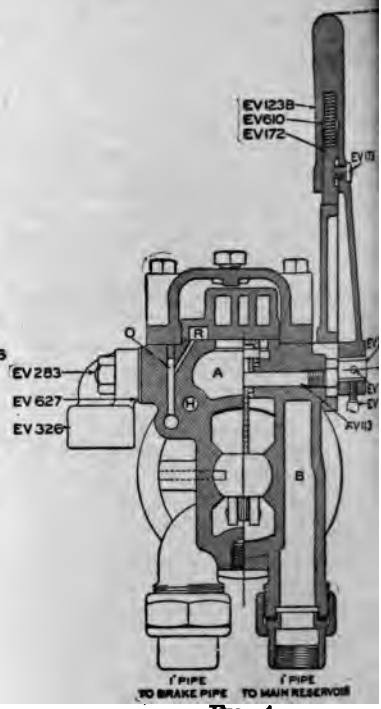


FIG. 4.

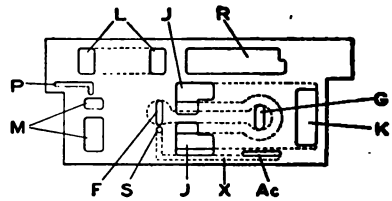


FIG. 5.

de to brake pipe pressure and on the other to chamber D or supplementary reservoir pressure, through the agency of lever EV 302 uses valve EV 317 to move automatically whatever distance is ecessary to close port F.

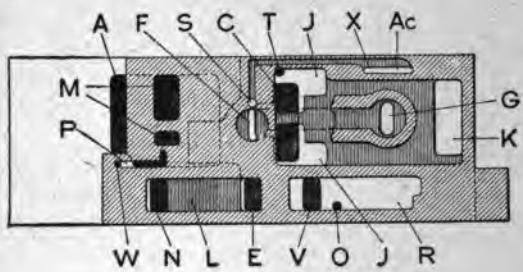


FIG. 6.

RELEASE POSITION.

AUTOMATIC RELEASE AND STRAIGHT AIR APPLICATION POSITION (Fig. 6). The purpose of this position is to promptly release nd recharge the automatic brakes and to apply the straight air rakes or retain the pressure in the locomotive and tender brake ylinders. In this position air flows directly from chamber B main reservoir), into chamber A (brake pipe), past the end of he slide valve and through ports M. Port O is open to the atmosphere through port V to permit piston EV 311 to return to its ormal position. Port T is open to the atmosphere through J and . The supplementary reservoir is being charged to brake pipe ressure through groove P and port W from chamber A. Port E s brought into communication with port N by passage L, permitting air to pass to the locomotive and tender brake cylinders hrough the straight air pipe and double check valve until shut off by the ¾" pressure controller, the regulating top of which is connected to the straight air pipe and adjusted at 40 pounds. By placing the valve handle about midway between release and running positions the straight air ports can be lapped, making it possible to increase or decrease the brake cylinder pressure as may be necessary.

RUNNING POSITION.

RUNNING AND STRAIGHT AIR RELEASE POSITION (Fig. 7). This is the proper position in which to place the handle when wishing to release the train and locomotive brakes simultaneously, or to release the straight air brake when it only has been applied.

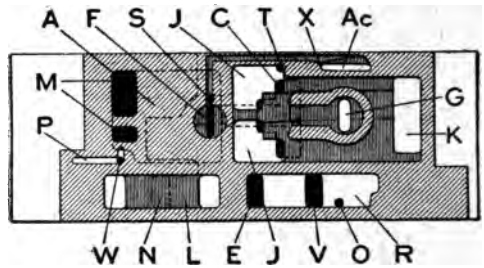


FIG. 7. RUNNING POSITION.

Air passes from the main reservoir to the brake pipe through por M. Port N is closed. Port E is brought into communicati with port V and the atmosphere by cavity R, releasing the straig air brake. Ports O and T are still open to the atmosphere as full release position. Port T is open to the atmosphere throu J and C in release and running positions, so that in case of a l lease following a partial application, the accelerator reserv pressure can escape and prevent the operation of the accelerat valve. Groove P still holds port W in communication with t brake pipe pressure in chamber A.

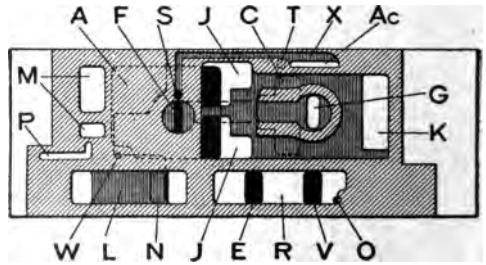


FIG. 8. LAP POSITION.

LAP POSITION (Fig. 8). The brake valve handle should b placed in this position when a hose bursts, the train parts or conductor's valve is opened to save the main reservoir air. Al ports are closed in this position excepting port O, which is ope to the atomsphere through port V and the exhaust passage in re lease, running and lap positions.

SERVICE APPLICATION POSITION (Figs. 9 and 10). This positio is for the purpose of gradually applying the brakes and is divide

into five graduating positions designated by notches on the quadrant. The reductions obtained in the different notches are respectively, 5, 8, 11, 15 and 23 pounds. The amount of the initial reduction should always be governed by the length of the train,

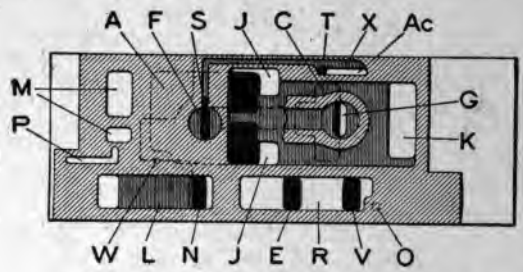


FIG. 9. FIRST GRADUATING NOTCH.

speed, grade, etc. Always place the handle of the brake valve in the notch which will give the required reduction. When the handle of the brake valve is moved to the first graduating notch the slide valve is in the position shown. Port O is closed to prevent the escape of chamber D pressure. Port F is moved back of the graduating valve EV 317 and port G registers with the exhaust port C. Brake pipe air now flows to the atmosphere. It also flows through port S, passage X and port T to the accelerator reservoir, building up a pressure to operate the accelerator valve.

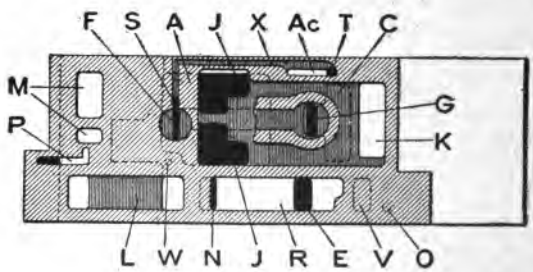


FIG. 10. LAST GRADUATING NOTCH.

As soon as the pressure in the brake pipe reduces, the pressure in chamber D, being now greater than brake pipe pressure, it begins to expand to equalize with the brake pipe pressure. In doing so it moves piston EV 311 forward. The piston carries with it the

lower end of the graduating valve lever EV 302, which is so proportioned that the graduating valve EV 317, on the other end of it, is just moved back far enough to close ports F and S when the pressures in chamber D and the brake pipe have equalized.

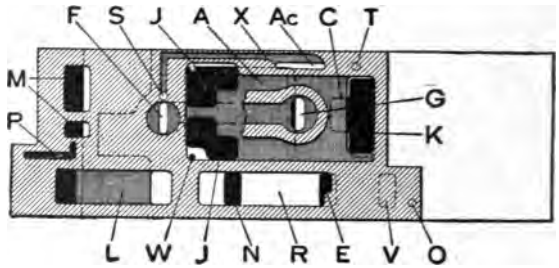


FIG. 11. EMERGENCY POSITION.

This stops the flow of air from the brake pipe to the atmosphere and to the accelerator reservoir (see accelerator valve). This action is called automatic lap and it takes place in all the graduating positions. A further reduction of the brake pipe pressure is made by moving the handle back to any of the service notches, the piston moving farther forward for each successive reduction. The

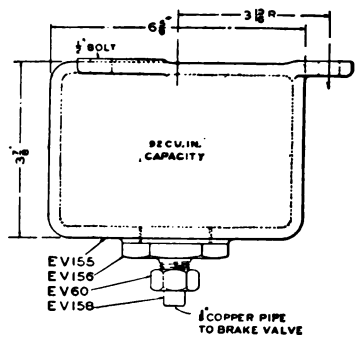


FIG. 12. SUPPLEMENTARY RESERVOIR. USED WITH SWITCH ENGINE EQUIPMENT, SCHEDULE B3-S.

action of the brake valve is the same and the ports are in the same relation to each other in all service positions of the brake valve except the last graduating position. In this position a partial

opening of port N admits air slowly to the locomotive and tender brake cylinders through cavity R and port E up to the adjustment of the controller on the straight air pipe. This is to insure full braking pressure on the engine with a full application, regardless of piston travel and brake cylinder leakage.

EMERGENCY APPLICATION POSITION (Fig. 11). This position is for the purpose of producing a quick, heavy reduction in brake pipe pressure so that all triple valves on the train will operate in quick action and apply the brakes in the shortest possible time.

Ports J register with chamber A and K with the exhaust port D, allowing brake pipe air to escape rapidly to the atmosphere. Cavity R allows air from the main reservoir to pass through ports N and E to the locomotive brake cylinders, and the full pressure of the straight air brake is maintained on the engine.

PRESSURE CONTROLLER.

The pressure controller is in reality, a part of the brake valve, taking place of the excess pressure or feed valves, and is connected on the main reservoir pipe near the brake valve to control brake pipe pressure. The principle of operation is the same as a pump governor. The regulating and supply portions are separate, being connected by piping, and the regulating heads connect directly to the pipe between the supply portion and the brake valve.

With the pressure controller the excess pressure is confined to the main reservoir, and while it has sufficient capacity to promptly release the brakes and recharge the auxiliary reservoirs on a train of any length, there is no danger of overcharging the auxiliary reservoirs on the forward end of the train. Thus the possibility of reapplication, due to the charging of the rear brakes when the auxiliary reservoirs on the forward end are overcharged, which is common without the use of the controller, is eliminated.

The controller is made in two styles, single and duplex, to cover the requirements of the different schedules. Figs. 14 and 15 are photographic views of a duplex pressure controller, regulating and supply portions. Fig. 16 is a sectional view of a duplex regulating portion and Fig. 17 a similar view of a single regulating portion. Figs. 18 and 19 show the four-way, three-way and cut-out cocks, which are used to control the air pressure to the regulating heads. Fig. 21 is a sectional view of the supply portion.

Referring to Fig. 21, connection with the main reservoir is made at MR, and by means of the cored passage air is free to pass to the under side of the valve, PG 95. Connection BV leads to the brake valve, main reservoir connection, and connection D to the regulating portion (single or duplex) connecting at D in Figs. 16 and 17.

In operation with either a single or duplex regulating portion, as soon as the pressure in the brake pipe is great enough to over-

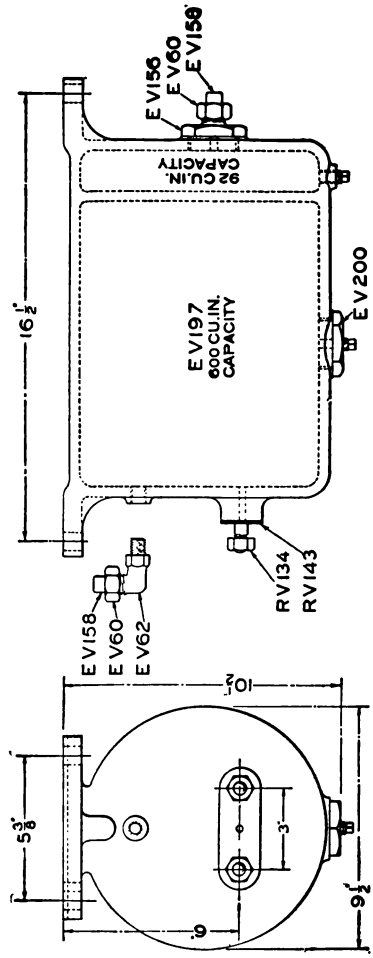


FIG. 13. DIVIDED RESERVOIR.

NAMES OF PARTS.

E V 60—Small union nut.
E V 62—Small union ell.
E V 156—Reservoir plug.
E V 158—Union swivel.
E V 197—Divided reservoir.
E V 200—Bottom plug.
R V 134—½" stud and nut.
R V 143—Accelerator valve gasket

come the resistance of the spring PG 10, which is holding the diaphragm PG 13, seated over port B, the pressure will pass through passage E to connection D, and by piping to the space E, in the supply portion of the controller above the piston PG 4, forcing the piston and valve PG 95 down until seated, cutting off communication between main reservoir and brake pipe.

As soon as the pressure falls in the brake pipe below the adjustment of spring PG 10, the latter will force diaphragm PG 13 to its seat, closing off port B, whereupon pressure in passage E and piping connecting supply and regulating portions and space E above piston PG 4 will immediately escape to the atmosphere through the small port C, in the regulating head of the controller, after which main reservoir pressure will lift valve PG 95 off its seat and again open communication to the brake valve, thus maintaining a constant pressure in the brake pipe.

Port X in the supply portion of the controller connects the under side of piston PG 4 with atmosphere, so that it will be free to operate and to discharge any leakage by the ring PG 24 or valve PG 95.

The regulating portions are provided with brackets, so that they can be attached to the cab in some convenient place where they will be handy for adjustment. The adjustment of these regulating heads is accomplished by means of nut PG 35, which regulates the tension of spring PG 10.

As each regulating head has a vent, port C, to avoid unnecessary waste of air, one of these heads should be plugged with a screw, PG 33, with all duplex regulating portions.

The hand wheel, PG 45, can be used in case of any defect that would cause a sluggish action of the controller. By screwing the wheel up, it will lift the valve, PG 95, off its seat and allow the free passage of air from the main reservoir to the brake valve. The controller will then be inoperative, main reservoir and brake pipe pressures will be equal until the controller is again restored to its operative condition.

By referring to the piping diagrams, it will readily be seen how the three-way cock is connected with the regulating heads in schedule B3-HP, and how the four-way cock is connected to the regulating heads and accelerator reservoir in schedule B3-HS.

As before stated, the cut-out cock shown in Fig. 20 is used with the B3-S equipment between the regulating and supply portions. When the cut-out cock is closed the supply portion of the controller is cut off, making it inoperative for the reasons stated in the instructions already given.

A ¾″ controller is used to control the straight air brake pressure. It is located in a ¾″ pipe, which is attached to the main reservoir pipe between the cut-out cock, No. 4 and the 1¼″ controller, and leads to the main reservoir connection of the pipe bracket, EV 326. The regulating head is connected to the straight air pipe between the pipe bracket and the double check

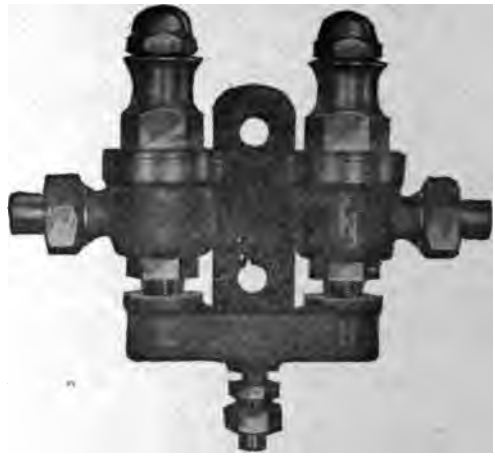


FIG. 14. DUPLEM REGULATING PORTION OF PRESSURE CONTROLLER.

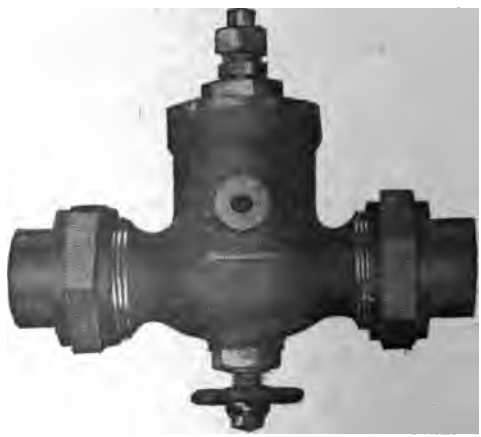


FIG. 15. SUPPLY PORTION OF PRESSURE CONTROLLER.

valve. It is adjusted to 40 pounds and maintains that pressure in the locomotive brake cylinders when the straight air brake is applied. Its operation is identical with that of the 1¼" pressure controller.

ACCELERATOR VALVE.

It is well known that with the ordinary brake valves alone, it is almost impossible to set all the brakes on trains of 75 to 100 cars without making a very heavy reduction. This is caused by the back flow of air from the auxiliary reservoirs to the brake pipe through the feed grooves, and from the brake cylinder to the atmosphere through the leakage grooves. It is the result of the comparatively slow brake pipe reduction through the service application ports of the brake valves, which for obvious reasons cannot be enlarged. The accelerator valve was designed to overcome this difficulty. Its duty is to assist the brake valve in discharging brake pipe air when making service applications on long trains, and to bring about a more uniform and prompt application of the brakes than is possible with the ordinary brake valves. It operates only when a service application of brakes is made with the brake valve and then only when the volume of brake pipe air is sufficient to warrant its use. The reductions, however, are no greater with the accelerator valve than with the former types of brake valves, as the automatic cut-off of the brake valve controls the flow of air that actuates the accelerator. This valve does exactly what its name would imply. It accelerates the discharge of brake pipe air. The operation of the accelerator valve is automatic, it opens about four seconds after the brake valve handle has been moved to the graduating notch and closes in about the same length of time after the graduating valve has closed ports F and S in the slide valve. It requires from about 10 to 12 pounds pressure in the large compartment of the divided reservoir to operate it, consequently, it does not open with a shorter train than eight cars, as with that length of a train the automatic lap of the brake valve takes place before sufficient pressure has been accumulated in the divided reservoir to move the piston of the accelerator valve down against the spring.

It is bolted to the divided reservoir, the large chamber of which is the accelerator reservoir and the small one the supplementary reservoir.

The arrangement of piping to it is shown in the piping diagrams. Fig. 22 is an outside view of the valve showing the brake pipe connection and exhaust elbow. Fig. 23 is a sectional view. The working parts are the piston BV 65, slide valve RV 64 and slide valve spring EV 656, valve stem RV 67, with leather seat RV 70 and spring QF 231.

Brake pipe pressure is always present in chamber O, around the slide valve RV 74, and is prevented from escaping to chamber

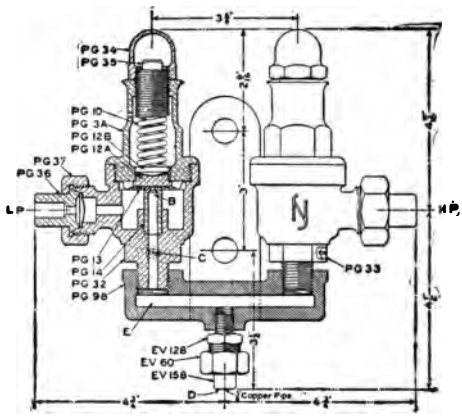

PG 34
PG 35
PG 10
PG 3A
PG 12B
PG 12A
PG 37
PG 36
LP
B
HP
C
PG 13
PG 14
PG 32
PG 98
PG 33
E
EV 128
EV 60
EV 158
D
Copper Pipe

FIG. 16.

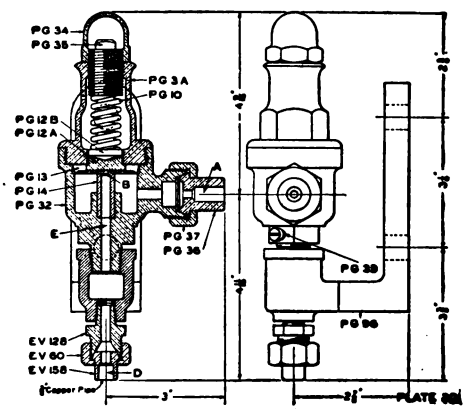

PG 34
PG 35
PG 3A
PG 10
PG 12B
PG 12A
PG 13
PG 14
PG 32
B
A
E
PG 37
PG 36
PG 38
PG 98
EV 128
EV 60
EV 158
D
Copper Pipe
3"
PLATE 901

FIG. 17.

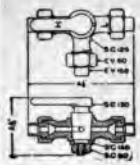


FIG. 18.

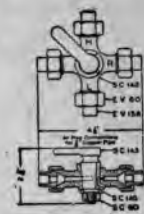


FIG. 19.

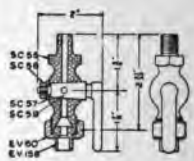


FIG. 20.

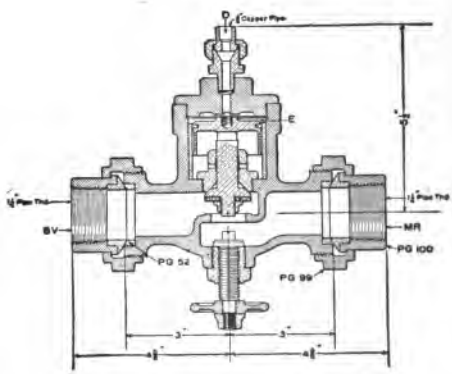


FIG. 21.

FIG. 22. ACCELERATOR VALVE.

by the leather seat RV 70, which is held to its seat by the ing QT 231. There is an oblong port, *a*, in the slide valve, a triangular port, *b*, in the slide valve bush, with its point up- d. When the brake valve is placed in the service position t S in the slide valve is open to the brake pipe, and the long t Ac, also in the slide valve, registers with port T in the seat- wing brake pipe air to pass through ports S and T to the elerator reservoir and to the top of piston RV 65, which is al- s in direct communication with the accelerator reservoir. When ressure of from 10 to 12 pounds is accumulated in the reser- , the piston, valve stem, and slide valve are moved down, com- ssing spring QT 231. Port *a* then registers with *b*, but as the ll part of the port opens first the brake pipe air flows slowly the atmosphere, the discharge increasing as the port opens er, until the full travel of the piston and slide valve gives a opening of the port. When the cut-off valve of the brake ve goes to automatic lap and closes port S, air stops flowing the accelerator reservoir. The pressure on piston RV 65 re- es through ports R and T in the body of the valve and through t S, in the piston. As soon as the pressure above the piston been reduced sufficiently, the spring QT 231 pushes the slide ve and piston upwards, first closing port R, then ports *a* and *b*, ly closing the leather seated valve RV 70, and stopping the of brake pipe air to the atmosphere. The piston closes port before the slide valve closes port *b*, so that the air from the elerator reservoir, flowing more slowly through the port S in piston, gives the slide valve the slow closure desired.

This action of the accelerator valve will allow a much larger ume of air to pass from the brake pipe than could flow in the ie time through the service ports F and G in the brake valve.

It stays open longer with a long train than with a short one, ause the volume of brake pipe air to be reduced is greater and cut-off valve EV 317 stays open longer.

The high speed controller is used with schedule B3-HS. Fig. is a photographic view and Fig. 25 is a sectional view of it, wing the operative parts. These are piston HS 107 with valve 108, which is provided with one large and one smaller annular ove, as shown, the spring RV 105A, valve stem RV 131, pop ve RV 133 and the lever handle RV 129.

It is connected to the brake cylinders at BC and the brake pipe BP. Its normal position is shown in the illustration, where it eld by brake pipe pressure. During all ordinary service appli- ions the piston remains in this position and brake cylinder ssure can pass freely to the safety valve through the large ove, when higher than that which safety valve is set to retain. wever, when an emergency application is made the brake pipe ssure is greatly reduced, the brake cylinder pressure will move piston and valve their full traverse to the seat C. This move- nt brings the smaller groove directly under the passage G,

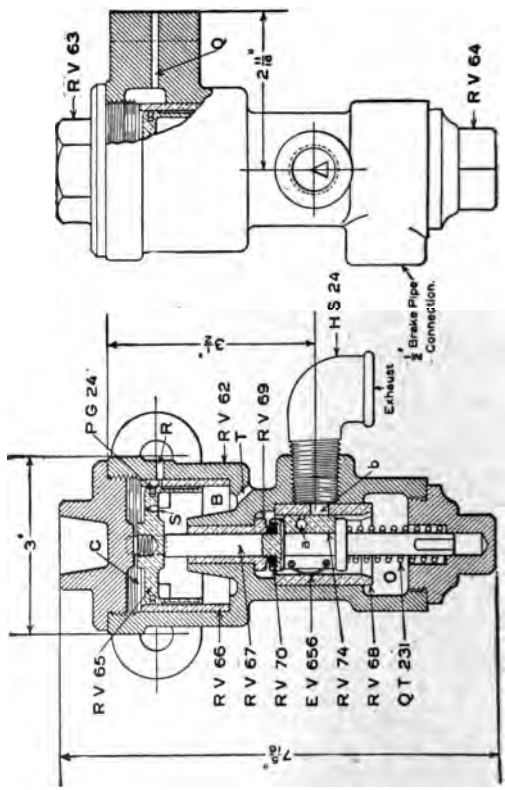

R V 63
Q
2 11/16"
R V 64
H S 24
Brake Pipe Connection.
Exhaust
P G 24
R
R V 62
T
R V 69
S
B
3"
C
a
b
O
R V 65
R V 66
R V 67
R V 70
E V 656
R V 74
R V 68
Q T 231

FIG. 23.

FIG. 24. HIGH SPEED CONTROLLER.

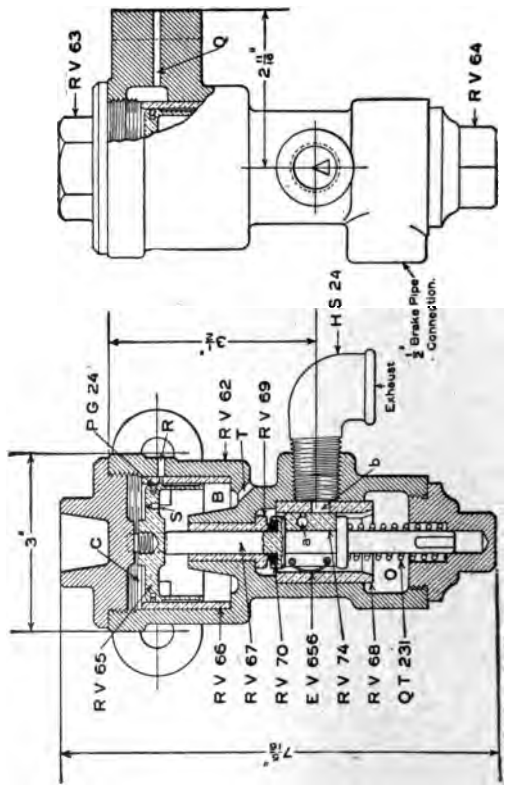
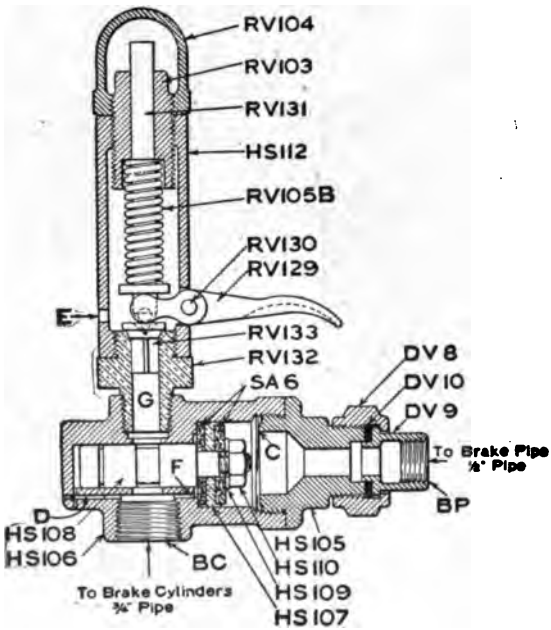

R V 63
Q
2 11/16"
R V 64
H S 24
½" Brake Pipe Connection.
Exhaust
P G 24
R
R V 62
T
R V 69
B
S
C
3"
R V 65
R V 66
R V 67
R V 70
E V 656
R V 74
R V 68
Q T 231
7 13/16"

FIG. 23.

FIG. 24. HIGH SPEED CONTROLLER.

which restricts the passage of brake cylinder air to the safety valve and causes a gradual blow down until stopped by the safety valve. The safety valves should be adjusted to 53 pounds, and



HIGH SPEED CONTROLLER LEVER SAFETY VALVE.

FIG. 25.

whether used alone or with the high speed controller are piped to the engine brake cylinders so that they will relieve the cylinders of all over that amount, whether obtained with the automatic or straight air application.

Ports F and D allow the brake cylinder pressure to circulate around the piston HS 107 and back of valve HS 108 so that they will move with a slight difference of pressure.

THE QUICK RELEASE VALVE.

The quick release valve shown in Fig. 27, as before stated, is for use with schedule B3-S switch engine equipment. This valve

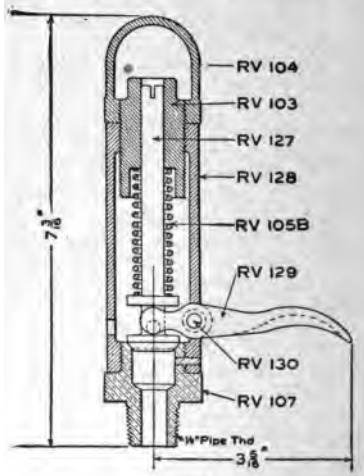

RV 104
RV 103
RV 127
RV 128
RV 105B
RV 129
RV 130
RV 107
7 3/16"
¼" Pipe Thd
3 5/16"

FIG. 26.

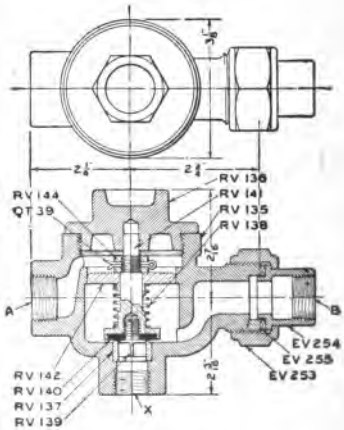

RV 144
QT 39
RV 136
RV 141
RV 135
RV 138
A
B
EV 254
EV 255
EV 253
RV 142
RV 140
RV 137
RV 139
X

FIG. 27.

is to hasten the release after an application of the automatic or straight air brakes. Referring to Fig. 27, connection A leads to the double check valve as shown in the piping diagram of this equipment. Connection B leads to the driver brake cylinders and connection X to the exhaust.

As soon as the brakes are applied by automatic or independent application pressure will pass to top of piston RV 142, forcing the same down against the resistance of spring RV 138 until it strikes the collar on valve RV 141, clearing the valve body enough to give a direct opening to the brake cylinders.

In effecting a release, as soon as the handle of the brake valve has been returned to release position, the pressure will be reduced from the upper side of the piston, allowing the pressure on the under side to operate it and lift the valve RV 141 off its seat to discharge the pressure from the brake cylinders to the atmosphere.

While the quick release valve is shown, in the piping diagram, between the double check and driver brake cylinders, it can, if desired, be placed in the straight air pipe between the brake valve and double check to hasten the release of the straight air brake on engine and tender, leaving the release of the automatic brake normal.

The double check valve is not shown here, as it is of an old and well understood design.

THE DUKESMITH ENGINE CONTROL AIR BRAKE EQUIPMENT NO. 6.

THE DUKESMITH ENGINE CONTROL AIR BRAKE EQUIPMENT NO. 6.

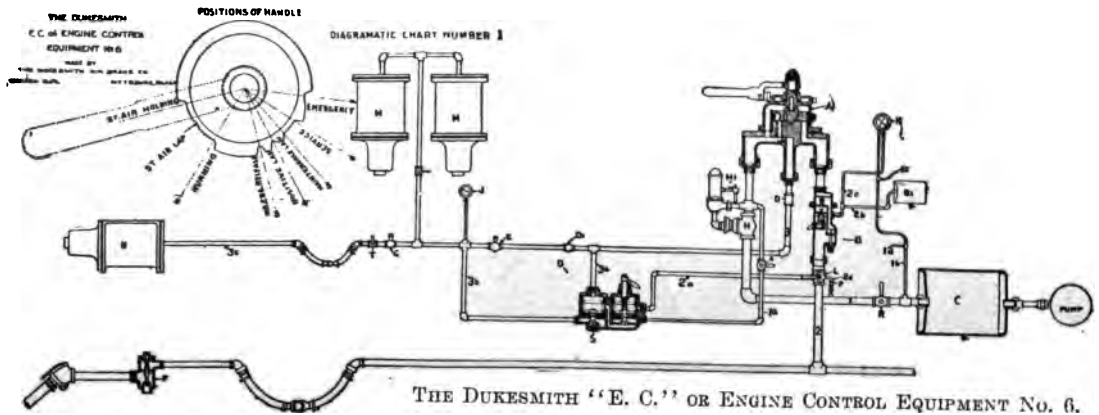
FUNCTIONS. It is claimed by its manufacturers that the functions of this equipment are: 1. Engine and tender brakes may be applied independently of the train brakes and without overcharging the train pipe. 2. Slack of the train may be taken by graduated application of locomotive brakes and immediately thereafter of the train brakes by using one handle. 3. Entire or graduated release of engine brakes without disturbing train brakes. 4. Engine brakes may be reapplied without making a further train pipe reduction or at the same time the train brakes are being harder applied. 5. Engine and train brakes released together as with an ordinary brake valve. 6. Release of train brakes while engine brakes are set. 7. Releasing engine brakes while train brakes are applied and reapplying and holding engine brakes while releasing train brakes with one movement of the handle. 8. Maintaining engine brakes against brake cylinder leakage with the triples at lap or release position. 9. Uniform pressure per square inch, regardless of piston travel, of engine and tender brake cylinders. 10. Automatic application of engine brakes in case hose bursts and continued application thereof, regardless of cylinder leakage. 11. Immediate release of engine brakes without releasing train brakes, after emergency application. 12. Quick train pipe reduction at train triples in double-heading emergency application, regardless of number of coupled engines.

OPERATION. The only features in its operation which differ materially from the operation of the standard Air Brake are:

First—When the handle of the valve is moved toward the left, from Running to Release Position, it applies the engine brakes without applying the train brakes, and by returning the handle to Running Position it releases the engine brakes.

Second—By placing the handle in the notch between Running and Lap Positions (known as Independent Release) it will release the engine brakes without releasing the train brakes.

Third—By placing the handle on Maintenance Lap Position it



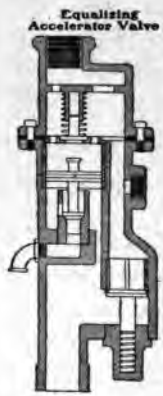
THE DUKESMITH "E. C." OR ENGINE CONTROL EQUIPMENT NO. 6.

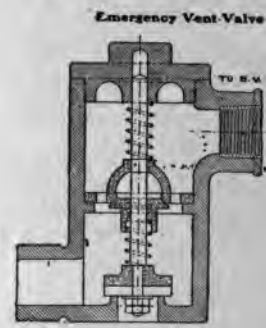
FUNCTIONS OF NO. 6 BRAKE VALVE.

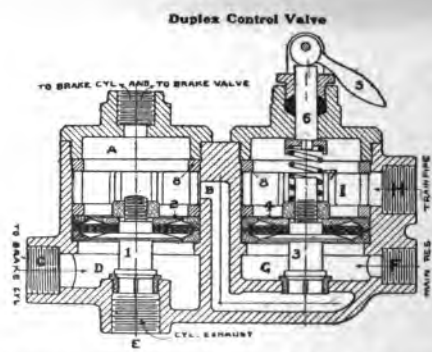
1st Position—Applies and Holds Engine Brakes While Releasing Train Brakes.
2nd " Releases Engine and Train Brakes.
3rd " Releases Engine Brakes While Holding Train Brakes.
4th " Closes all Ports.
5th " Gradually Applies Engine Brakes or Keeps Them Applied Against Cyl. Leakage.
6th " Applies Engine and Train Brakes in Service.
7th " Applies Engine and Train Brakes in Emergency.

INDEX TO CHART.

A—Brake Valve.
B—Equalising Accelerator Valve.
B1—Equalising Reservoir.
C—Main Reservoir.
D—Duplex Control Valve.
D1—Non-Return Check Valve.
E—Brake Cylinder Reducing Valve.
F—Emergency Vent Valve.
G—Safety Valve.
H—Pressure Controller.
H1—Pressure Controller Valve.
J—Brake Cylinder Gage.
K—Duplex Gage.
L—Train Pipe Cut-Out Cock.
M—Drive Brake Cylinders.
N—Tender Brake Cylinders.
O—Partial Check Valve.
P—Double Heading Check Valve.
Q—Cut-Out Cock.
R—Cut-Out Cock.
S—Eng. Brake Cylinder Exhaust.
T—Cut-Out Cock.
1—Main Reservoir Pipe.
1a—Supply Pipe to Duplex Control Valve.
1b—Pump Governor Pipe.
1c—Pump Governor Connection.
1d—Air Sander.
2—Train Pipe.
2a—Branch Pipe to Duplex Control Valve.
2c—Train Pipe Gage.
2d—Double Heading Pipe.
3—Eng. Brake Cylinder Pipe.
3a—Cyl. Branch Pipe to Dupx. Con. Valve
3b—Brake Cylinder Exhaust Pipe.
3c—Tender Brake Cylinder Pipe.
2b—Branch Pipe to Equalising Reservoir.







DETAILS OF EQUALIZING ACCELERATOR VALVE, EMERGENCY VENT VALVE, AND DUPLEX CONTROL VALVE OF DUKESMITH, E. C. OR ENGINE CONTROL EQUIPMENT NO. 6 SHOWN IN CHART.

will cause the engine brakes to apply very gradually or keep them applied against cylinder leakage, without applying the train brakes.

POSITIONS. The positions on the brake valve are arranged in the usual order. The valve handle is moved toward the left when releasing train brakes, and toward the right when applying train brakes.

The first position, to the extreme left, is Straight Air and Holding Position. This puts the engine brakes on or keeps them on while the train brakes are being released.

The second is Running Position, which releases both the engine and the train.

The third is Independent Engine Release, which lets the engine brakes off without releasing the train brakes.

The fourth is Positive Lap, when the ports are all closed.

The fifth is Maintenance Lap, which allows main reservoir pressure to flow to the engine brake cylinders while the train pipe exhaust is kept closed.

The sixth is Service; in this position the train pipe pressure is allowed to exhaust through a small opening, while the main reservoir pressure is allowed to flow to the engine brake cylinders, thus making a straight air application on the engine while the train brakes are being applied automatically.

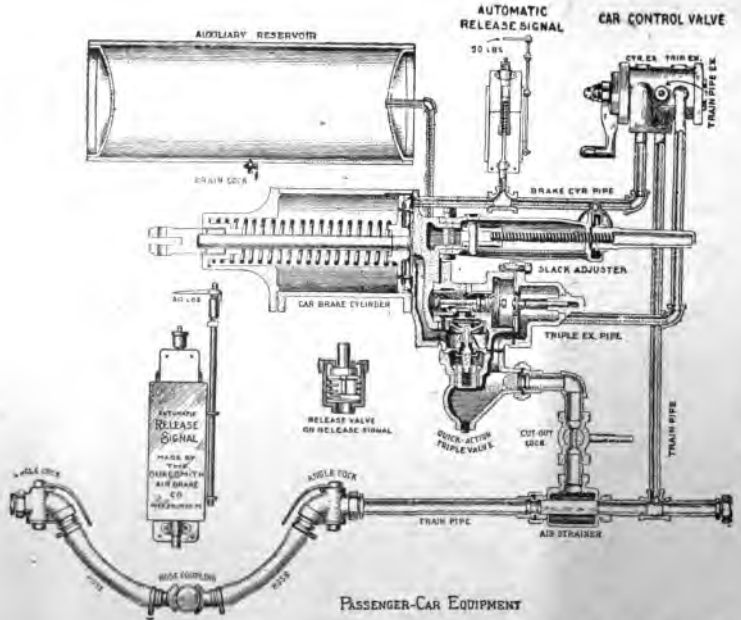
The seventh is Emergency; in this position the train pipe exhaust is wide open and the main reservoir pressure is free to pass into the engine brake cylinders.

Straight Air Lap Position is about midway between Holding and Running Positions.

The Equalizing Discharge Valve is located in the train pipe just below the brake valve; it is also an Accelerator Valve, because it accelerates, or quickens the flow of air from the train pipe when the surge rushes forward from a long train pipe, thereby insuring full braking power regardless of the length of the train.

When a hose bursts the driver brakes may be immediately released by closing the cut-off cock marked Q, as shown on the Chart, and placing the handle of the brake valve on Independent Release Position.

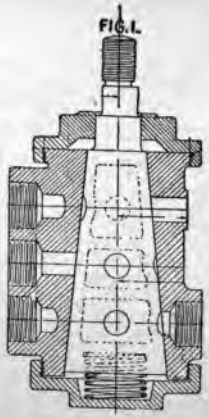
The Dukesmith Car Control Valve is intended for use on both freight and passenger cars. It is connected to the exhaust port of the triple and to the brake cylinder and to the train pipe, and hence enables trainmen to independently close the triple exhaust or open the brake cylinder without regard to the action of the triple valve and also to open the train pipe to the atmosphere either suddenly or gradually, thus making either a service or emergency application of the brakes on the entire train, as may be desired.



PASSENGER-CAR EQUIPMENT

DUKESMITH CAR CONTROL VALVE.

FIG. I.



SECTIONAL VIEW DUKESMITH CAR CONTROL VALVE.

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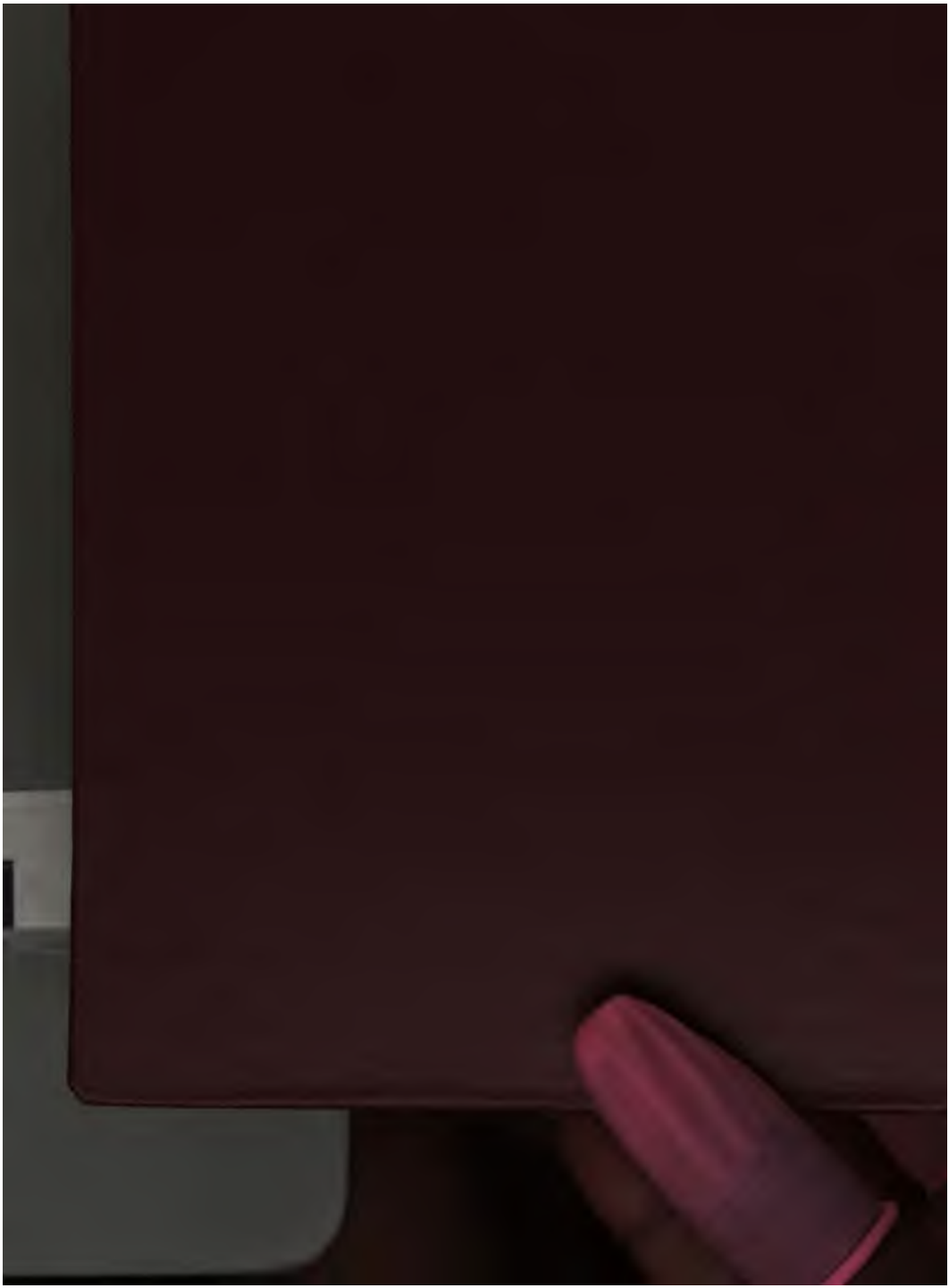
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